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Geography and Regional Income Convergence among Brazilian states [1]

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1. Introduction

In mainstream economics, the starting point for understanding the existence of poor regions is the neoclassical exogenous growth model developed by Solow and Swan in 1956. According to this model, per capita income differentials among regions are determined by their respective initial endowments of resources, so that it is not so much that there are poor regions, as given areas that have a greater concentration of poor families. Such models are presented in greater detail in Barro and Sala-i Martin (1995).

Recent studies, such as Hall and Jones (1996), Chang (1994), Ravallion and Jalan (1996) and Jalan and Ravaillon (1998b) have highlighted the importance of geographical, institutional and political variables in determining regional income differentials. According to these authors, in certain circumstances the presence of poor families is determined endogenously, and not by the more widespread exogenous variables assumed in growth

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models. Differing levels of 'geographical capital', such as climate, local infrastructure, access to public services and the knowledge about the local physical reality and adequate technologies, would influence the use of private capital. That is, geographical variables would affect the marginal return of private capital. The imperfect mobility of factors, usually assumed in this sort of models, would create the conditions for the persistency of inequalities. The coexistence of increasing returns to geographical capital with non-increasing returns to private capital is conceivable in this line of reasoning. Poor people tend to live in poorly supplied regions. With the same personal characteristics, they would be better of if living in a richer region.

This difference in diagnosis is reflected in the important issue of policy recommendations. According to the first class of models, regional inequality is to be solved by allowing free mobility of factors, that should in turn result in long-term convergence of growth rates. The second strand of the literature, on the other hand, can be used to justify regional policies aiming at reducing regional inequality, such as public investments in 'geographical capital'.

The objective of this paper is to offer evidence on this controversy in the case of state income inequalities in Brazil over the period 1981-1996. In section 2 some general information on regional inequalities in Brazil is provided as well as a review of the some existing empirical studies, creating the background for the study to be performed in the paper. Section 3 presents a methodological discussion of the model to be estimated. Section 4 presents the data used in the research and discusses the advantages and limitations of using micro-data. Section 5 presents and discusses the econometric results, which are commented on in the concluding section.

2. Regional inequalities in Brazil

Brazil is well known for its high levels of regional income inequalities. In 1960, Brazil had a GDP per capita of US$ 1,449. Thirty-five years later, in 1995, this figure had risen to US$ 3,556, corresponding to an average growth of 2.6% per year. Data on per capita GDP for Brazilian states (see figures 1 and 2 in the appendix) indicate that only three

Brazilian states had figures above the national average, namely, São Paulo, Rio de Janeiro and Rio Grande do Sul. The state of São Paulo was notable for a GDP per capita that was almost 2 times the national average. The poorest state was Piauí, with a GDP per capita that was 4.5 times less than the Brazilian average, and 8.9 times less than that of the state of São Paulo. It is notable that nine of the ten poorest states in Brazil were in the Northeast, and three of the four states of the Southeast were among the five richest states in Brazil.

In 1995 a larger number of states were above the national average. Of these, the first two, São Paulo and Rio de Janeiro, are in the Southeast region, while the next three, Rio Grande do Sul, Paraná and Santa Catarina, belong to the South region. The other Southeastern states achieved visible improvements with regard to the national average (e.g. the state of Mato Grosso). Of the ten poorest states, eight are in the Northeast, and two in the North region, Amazonas and Pará, were notable for having declined in relative terms since 1960, to stand among the ten states with the lowest GDP per capita. São Paulo was still the richest state in 1995, with a GDP per capita that was 1.7 times the national average, with an average growth rate of 2.1% per year between 1960 and 1995, 0.5% below the national growth average. Piauí, on the other hand, was still the poorest state in Brazil. It is nevertheless interesting to note, however, that while in absolute terms the state's position was considerably worse than the rest of the country, in relative terms it had improved, with a GDP per capita that was 3.7 times smaller than the national average, and 6.1 times smaller than that of the richest state. Another interesting point is that the state of Piauí GDP per capita grew 3.1% per year, one percentage point above that of the state of São Paulo for the same period. These observations raise the question as to whether or not there is an income convergence trend among Brazilian states.

Taking the neoclassical growth model as a basis, Ferreira and Diniz (1995), Schwartsman (1996) and Zini (1998), analyzing the period initiated in 1970, could not reject the hypothesis of absolute convergence. They estimated speeds of convergence among Brazilian states that were above the levels predicted by the model. Azzoni (1999), working with a longer series (1939-1996) also found indications of absolute convergence of income, but at a much lower speed. It remains to be investigated whether there are

spatial externalities that conditions regional growth. That is to say, geographical characteristics such as climate, public and private infrastructure (which could be understood as reflecting 'geographical capital') may be affecting the growth rates of states or regions, by influencing the productivity of individual or family capital. This would have decisive implications for public sector policies designed to combat poverty and to improve incomes at regional and state level, since differences in living standards would result not only from the initial conditions of families, as assumed by neoclassical growth models, but also from differences in the 'geographical capital' between regions.

Since the previous models used for calculating convergence did not consider the effect of geographical variables and these would tend to be positively correlated with initial income, their results could be in fact reflecting conditional instead of absolute convergence and could be under-estimating the true velocity to this convergence. We thus propose to estimate the variation in household income per capita for Brazilian states as a function of geographical, state and household variables, in order to capture not only the influence of the individual characteristics of households on the convergence or divergence of per capita income (along the lines of the neoclassical model), but also that of spatial or geographical characteristics.

3. Theory

This section aims at presenting the neoclassic growth model with exogenous savings, geographic variables and fixed effects, as in Islam (1992), to be taken to the data. Consider the production function, with labor augmenting technical progress:

$$Y(t) = K^{\alpha}(t)(A(t)L(t))^{1-\alpha}G$$

Where Y = product, K = capital, L = labour e G = geographic capital geographic (fixed in the economy) . The public input is thus complementary to private inputs, and we have:

$$L(t) = L(0)e^{nt}$$
$$A(t) = A(0)e^{gt}$$

where n and g are the (exogenously determined) population and technology rates of growth. Capital accumulation per effective worker in the steady state will be given by:

$$\frac{d\hat{k}}{dt} = s\hat{y} - (n + g + \delta)\hat{k},$$

where $\hat{y} = \frac{Y(t)}{A(t)L(t)}$, $\hat{k} = \frac{K(t)}{A(t)L(t)}$, s = exogenous saving rate and δ = the depreciation rate.

This equation implies steady state levels of capital and product (per effective worker) described by:

$$\hat{k}^* = \left(\frac{s.G}{n + g + \delta}\right)^{\frac{1}{1-\alpha}}$$
$$\hat{y}^* = \left(\frac{s}{n + g + \delta}\right)^{\frac{\alpha}{1-\alpha}} .G^{\frac{1}{1-\alpha}}.$$

With the product per effective worker given by $\hat{y}(t) = \hat{k}^{\alpha}(t)G$, we can approximate its time variation around the steady state to get (in logs):

$$\frac{d\ln(\hat{y}(t))}{dt} = \lambda[\ln(\hat{y}^*) - \ln(\hat{y}(t))],$$
$$\lambda = (1 - \alpha)(n + g + \delta).$$

We can now take the growth of per capita product during the period τ = t2 - t1 by substituting the above value of $\hat{y}^*$:

$$\ln(y(t2)) - \ln(y(t1)) = (1 - e^{-\lambda\tau})\frac{\alpha}{1-\alpha}\ln(s) - (1 - e^{-\lambda\tau})\frac{\alpha}{1-\alpha}(n + g + \delta) + \frac{1}{1-\alpha}(1 - e^{-\lambda\tau})\ln(G)$$
$$-(1 - e^{-\lambda\tau})\ln(t1) + g(t2 - e^{-\lambda\tau}t1) + (1 - e^{-\lambda\tau})\ln(A(0)).$$

Where we have used the fact that $\ln(\hat{y}(t)) = \ln(y(t)) - \ln(A(0)) - gt$.

One can include human capital in the production function:

$$Y(t) = K^{\alpha}(t)H^{\beta}(t)(A(t)L(t))^{1-\alpha-\beta}G$$

Where H is the stock of human capital and β its coefficient (0<β<1). We now let s_k and s_h be the fraction of income invested in physical and human capital, respectively. Thus, we will have the evolution of these capital per effective worker given by:

$$\frac{d\hat{k}(t)}{dt} = s_k\hat{y}(t) - (n+g+\delta)\hat{k}(t)$$

$$\frac{d\hat{h}(t)}{dt} = s_h\hat{y}(t) - (n+g+\delta)h(t),$$

In fact, we are assuming the same production function applies to human capital, physical capital and consumption. Additionally, by assuming α+β<1, we preserve the decreasing marginal returns to capital and can study the steady state characteristics of the model.

From both equations above we can obtain the steady state levels of physical and human capital:

$$\hat{k}^* = \left(\frac{s_k^{1-\beta} s_h^{\beta} G}{n+g+\delta}\right)^{\frac{1}{1-\alpha-\beta}}$$

$$\hat{h}^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha} G}{n+g+h}\right)^{\frac{1}{1-\alpha-\beta}},$$

Substituting into the production function we obtain the product of steady state:

$$\hat{y}^* = \frac{s_k^{\frac{\alpha}{1-\alpha-\beta}} s_h^{\frac{\beta}{1-\alpha-\beta}} G^{\frac{\alpha+\beta}{1-\alpha-\beta}}}{(n+g+\delta)^{\frac{\alpha+\beta}{1-\alpha-\beta}}}.$$

We now approximate the income variation around the steady state to obtain:

$$\frac{d\ln(\hat{y}(t))}{dt} = \lambda\left[\ln(\hat{y}^*) - \ln(\hat{y}(t))\right],$$

where λ = (1-α-β)(n+g+δ).

Solving this equation we can get:

$\ln(\hat{y}(t)) = (1-e^{-\lambda t})\ln(\hat{y}^*) + e^{-\lambda t}\ln(\hat{y}(0))$.

Now we subtract the log of initial product per effective worker and substitute for stead state level of product:

$$\ln(\hat{y}(t)) - \ln(\hat{y}(0)) = (1-e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln(s_k) + (1-e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(s_h) - (1-e^{\lambda t})\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta)$$
$$+\frac{1}{1-\alpha-\beta}\ln(G) - (1-e^{-\lambda t})\ln(\hat{y}(0)).$$

If we take this equation in per capita terms and consider the time period t2 – t1, we get:

$$\ln(y(t_2)) - \ln(y(t_1)) = (1-e^{-\lambda\tau})\frac{\alpha}{1-\alpha-\beta}\ln(s_k) + (1-e^{-\lambda\tau})\frac{\beta}{1-\alpha-\beta}\ln(s_h)$$
$$-(1-e^{-\lambda\tau})\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{1}{1-\alpha-\beta}\ln G - (1-e^{-\lambda\tau})\ln(y(t1)) + (1-e^{-\lambda\tau})\ln(A(0))$$
$$+g(t_2 - t_1 e^{\lambda\tau})$$

where τ = t2 –t1.

4. Econometric Methodology

This section aims at representing the last equation in an form that is estimable with the data in hands. As the main aim of this version of this research is to investigate the roles of geographic and human capital variables on growth, we propose:

$$\Delta y_{it} = \gamma y_{it-1} + S_i + \beta_1 H_{it} + \beta_2 G_{it} + \eta_t + \varepsilon_{it}$$

Where:

$$y_{it-1} = \ln y(t1),$$
$$\Delta y_{it} = \ln y(t2) - \ln y(t1)$$
$$\gamma = \left(1 - e^{-\lambda\tau}\right)$$
$$S_i = \left(1 - e^{-\lambda\tau}\right)\frac{1}{1-\alpha-\beta}[\alpha \ln s_k - (\alpha+\beta)\ln(n+g+\delta) + \ln A(0)/\frac{1}{1-\alpha-\beta}]$$
$$\eta_t = g\left(t2 - e^{-\lambda\tau}t1\right)$$

where G and H are human capital and geographic variables.

4.1 The Construction of Cohorts

The data we use come from repeated cross-sections of very rich household surveys, carried out by the Brazilian Census Bureau (see below). The use of micro data to examine issues of convergence has not, as far as we know, been done in the literature before. It is well known in the consumption and labor supply literature (see Browning et al 1985, Attanasio and Browning, 1994) that with repeated cross-sections it is possible to construct demographic cohorts, based on date of birth calculate cohort-year means for all variables of interest, including income, education, labor force participation and living conditions. We propose to extend this methodology to include the State of residence as another grouping variable and derive state-cohort-year means for the variables of interest. For example:

$$\bar{y}_{csy} = \frac{\sum_{i}^{n_{csy}} \ln y_i}{n_{csy}} \qquad (11)$$

where: n_{csy} is the proportion of household heads born in an interval of determined years (e.g. 1940 to 1945) and living in state S in period t. (we contructed 10 birth cohorts). We use the same procedure for all other variables incldued in the analysis.

The advantages of such a procedure are many-fold. Firstly and most importantly, the use of micro-data allows us to control for changes in the composition of the population in each State, that cannot be controlled for with the use of aggregate data (see Stoker).

Secondly, we can control for life-cycle and generation effects, which means that we are in effect, considering the effect of geographic variables on income growth and convergence within a generation or for a population with the same age. Thirdly, one can identify state fixed effects without having to rely only on the time component of the series, since we have got various (10 in our case) observations for a given state in a given year. Finally, one can rely on differences across generations within a state-year group to identify the effects of human capital on growth, for example, that are not readily identified using aggregate data (Islam, 1994). The main disadvantage of using cohort level data is that is there are measurement errors at the household level they are likely to be carried out to the cohort means, unless the cell sizes are big.

In effect, we will be estimating an equation of the form:

$$\Delta y_{ict} = \gamma y_{ict-1} + S_i + \beta_1 H_{ict} + \beta_2 G_{ict} + \beta_3 X_{cit} + \beta_4 LF_{cit} + \eta_t + \varepsilon_{it}$$

Where the subscript *c* means that the variables are now cohort-state-year means, *X* = houdehold controls and *LF* = life cycle variables.

4. Data and data sources

The implementation of the model described above requires panel data, not easily available in general. In the case of Brazil we have repeated cross-sections of a yearly household survey (PNAD - Pesquisa Nacional por Amostra de Domicílios) conducted by IBGE, the Brazilian Census Bureau, that can be used as a pseudo-panel, by constructing a model that looks like an individual-level model but is for cohorts (see Ravallion,1998). Due to data limitations, only 19 out of 27 states were considered in the study; the excluded states belong to the almost uninhabited Northern region (including the Amazon region).

Descriptive Statistics

The main variables in the analysis are as disposed in Table 5. The dependent varialbe used throughout is per capita monthly labor income from the main job. We have also used two other variables, hourly labor income and total income with no apparent change in the results.

The human capital variables we use are education of the head, education of the partner and a measure of children delay in education. The geographic variables include access to public sewage, water, light and garbage systems, urban and metropolitan areas, infant mortality and life expectancy (as health indicators) and some climate variables. The life cycle variables include age and participation of head, partner and children. Controls variables include the sex of head and measures of household wealth such as household density and whether the household has a stove and fridge. We also include time and cohort dummies. The correlations among the main variables used in the analysis is presented in Table 1. The results are quite intuitive, indicating the income level is positively correlated with all human capital, geographic, wealth and participation indicators. The same results is basically maintained with respect to income growth

Figures 3 to 36 in the appendix present an exhaustive description of the data, in order to describe the main features of them, as well as examine the consistency of the information on the mains variables used in the analysis between surveys.

5. Econometric results

We now present the main results of estimating equation ( ). In table 2 the coefficients of the lagged dependent variable are presented together with the implied λ and the estimated velocity to half convergence. The upper part of the table refers to the results without the state dummies as opposed to the bottom half. In column (1) there are no other variables apart form the lagged dependent variable. This does not take account of the within state variation in cohorts. The estimated coefficient is very small and not

significantly different from zero, which basically implies persistence in income differences among states. Column (2) then includes the time and cohort dummies. The results are quite striking. Once we allow for differences in birth cohorts, the coefficient on the lagged dependent variable is significant and quite big, which means that once one controls for the different periods in the life cycle, there is absolute converge in income among Brazilian states.

In column (3) (bottom part of the table) we include the state dummies, to control for differences in technology, saving rates, population growth, preferences as well as institutional among states. The results indicate that once you control for differences in the steady-state growth rate among states, convergence (conditional convergence) actually takes place at a fast rate. Columns (4) to (8) in the upper part of the table shows that this is true even without controlling for the state fixed effects, but using human capital, participation or geographic variables instead. Columns (4) to (8) in the bottom part of the table show that once you control for state dummies, the marginal effect of the other variables on the speed of convergence is quite small.

In Table 3 the results of the state dummies are reported. The aim of reporting this coefficients is to examine the to what extent the states differ in unobserved characteristics that are constant over time, such as technology, preferences, institutions, etc.,. Furthermore, we want to shed light on the effect the other group of variables may have on the fixed effects, that is, to what extent some of human capital and specially geographic variables can "explain" part of the estimated specific effects.

The states are ordered according to the average income level. Column (1) confirms this by presenting the results of a regression of income growth on state, time and cohort dummies. Column(2) includes the human capital variables and we can notice that some of the differences between the state dummies and the reference state (Espirito Santo) disappear. The effects of participation and household characteristics do not change the basic results. There is however an important impact of the infra-structure variables on the estimated fixed effects. In column(5) there is almost no significant differences among the coefficients. The effect of the proxies for the quality of health services are quite striking

as well. The results presented in column(7) show that the differences in the estimated coefficients are now reverted. This means that differences in infant mortality rates are also behind the state effects.

In Table 4, the coefficients (standard errors) of the human capital, life cycle, participation, infra-structure, health and climate variables are set out. In the first column, one can note that education of the head and of children are quite important in explaining income growth. Moreover, the effects of labor market participation are quite important, and they seem to be proxying for life-cycle effects, as the age variables are now driven into insignificancy. In column (4), the results indicate that percentage of population living in metropolitan regions and access to garbage collection are positively correlated with income growth. The results in column (5) and (6) are also very important as they indicate that the quality of health services is strongly correlated with growth, even conditionally on state fixed effects and lagged income per capita. In column(7), the lagged level is omitted from the regression, and it seems that household density, metropolitan percentage and urban percentage are all positively correlated with the omitted variables, as they now appear as insignificant.

6. Conclusions

The main objective of this paper is to shed some light on the effects of geographic variables on income per capita pattern of growth in different states in Brazil. To achieve this aim, we proposed, for the first time in this strand of the economics literature, a methodology to examine the issue of convergence using micro-data. We constructed cohort/state/year averages of all variables of interest, and regressed income growth on a variety of human capital, life-cycle and geographic variables.

The main results indicate that geographic variables are important in explaining the difference in income growth across the Brazilian States. This is shown by they joint impact on the growth regressions and by the effects that their inclusion has on the state fixed effects. They also show that conditional convergence would take place rapidly in

Brazil, once State Effects, human capital or geographic variables are controlled for. Moreover, there is some evidence that within cohort convergence takes place at a faster rate than across generations.

Altogether, the results indicate that human capital and geographic variables are important areas for government intervention, as these are the mains factor behind the differences in steady-state rate of growth of income.

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Table 1 – Correlations among variables

	Ln(w)	Dln(w)	Educ_ head	Sex_ head	Part_ head	Educ_ part	Part_ ch	Stove	Fridge	HH dens	Metrop	Urban	Water	Light	Sewage	Garbage	Rainfall	Latit	Temp.	life expect.	Infant mort.
Ln(w)	1																				
D ln(w)	0.378*	1																			
Educ_head	0.710*	0.134*	1																		
Sex_head	0.541*	0.178*	0.497*	1																	
Part_part	0.208*	0.110*	0.418*	0.321*	1																
Educ_part	0.664*	0.153*	0.946*	0.656*	0.517*	1															
Part_children	-0.266*	-0.095*	-0.594*	-0.677*	-0.233*	-0.710*	1														
Stove	0.433*	0.033	0.476*	-0.012	0.043*	0.385*	0.048*	1													
Fridge	0.558*	0.036	0.658*	-0.051*	0.252*	0.495*	0.107*	0.666*	1												
HH Density	0.002	0.077*	-0.187*	0.488*	0.159*	-0.011	-0.255*	-0.492*	-0.561*	1											
Metrop	0.296*	0.008	0.414*	-0.078*	-0.013	0.255*	-0.063*	0.316*	0.419*	-0.174*	1										
Urban	0.508*	0.063*	0.652*	-0.039*	0.039*	0.494*	-0.072*	0.711*	0.773*	-0.485*	0.605*	1									
Water	0.554*	0.053*	0.617*	-0.019	0.004	0.467*	0.031	0.698*	0.838*	-0.506*	0.448*	0.785*	1								
Light	0.455*	0.039*	0.662*	-0.074*	0.264*	0.531*	-0.019	0.743*	0.881*	-0.612*	0.376*	0.805*	0.818*	1							
Sewage	0.536*	0.029	0.605*	-0.059*	-0.03	0.429*	0.054*	0.690*	0.821*	-0.508*	0.535*	0.839*	0.853*	0.792*	1						
Garbage	0.505*	0.03	0.609*	-0.071*	0.093*	0.460*	0.011	0.672*	0.818*	-0.527*	0.447*	0.864*	0.800*	0.834*	0.830*	1					
Rainfall	0.419*	0.002	0.314*	0.144*	0.050*	0.221*	0.086*	0.105*	0.490*	-0.191*	0.073*	0.165*	0.327*	0.231*	0.364*	0.270*	1				
Latitude	0.607*	0.033	0.548*	0.067*	-0.002	0.384*	0.063*	0.581*	0.788*	-0.495*	0.377*	0.602*	0.749*	0.630*	0.704*	0.645*	0.645*	1			
Temp	-0.546*	-0.033	-0.450*	-0.099*	-0.040*	-0.333*	-0.062*	-0.547*	-0.664*	0.451*	-0.228*	-0.498*	-0.592*	-0.535*	-0.510*	-0.541*	-0.454*	-0.858*	1		
life expec.	0.251*	0	0.473*	-0.157*	0.449*	0.362*	0.119*	0.419*	0.738*	-0.620*	0.158*	0.463*	0.485*	0.681*	0.505*	0.539*	0.429*	0.534*	-0.522*	1	
infant mort.	-0.455*	-0.01	-0.530*	0.018	-0.189*	-0.391*	-0.103*	-0.519*	-0.775*	0.563*	-0.214*	-0.536*	-0.624*	-0.6175*	-0.642*	-0.539*	-0.605*	-0.756*	0.685*	-0.839*	1

Tabela 2: Convergence

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
With out State Dummies								
Constante	0.0153	0.0119	-	-0.4102	-1.0494	-1.1867	-1.3909	-4.6780
	(0.0334)	(0.2977)		(0.4476)	(0.4139)	(0.4216)	(1.6253)	(1.5921)
$Ln(w_0)$	-0.0086	-0.0510	-	-0.2257	-0.3027	-0.4021	-0.4058	-0.5589
	(0.0086)	(0.0085)		(0.0159)	(0.0166)	(0.0192)	(0.0215)	(0.0223)
Implied λ	0.00863	0.05238	-	0.2558	0.3605	0.5978	0.5206	0.8183
R2	0.0005	0.3915		0.4630	0.5167	0.5585	0.5587	0.6121
With State Dummies								
Constante	-	-	0.5250	0.1620	-0.3730	0.4266	-6.1848	-
			(0.3994)	(0.4442)	(0.3889)	(0.4233)	(2.3272)	
$ln(w_0)$	-	-	-0.3852	-0.4514	-0.6036	-0.6534	-0.6842	-
			(0.0248)	(0.0256)	(0.0236)	(0.0240)	(0.0240)	
Implied λ	-	-	0.4864	0.6003	0.9253	1.0595	1.1522	-
State Dummies			x	x	x	x	x	
R2			0.4882	0.5285	0.6311	0.6452	0.6641	
Time Dummies		x	x	x	x	x	x	x
Cohort Dummies		x	x	x	x	x	x	x
Human Capital				x	x	x	x	x
Participation					x	x	x	x
Infra-Structure						x	x	x
IDH variables							x	x
Climate variables								x
Sample Size								

Table 3 : State Dummies – Dependent Variable is $\Delta \ln(w)$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
São Paulo	0,277	0,233	0,365	0,360	0,033	0,045	-0,068	-0,423
	(0,030)	(0,032)	(0,030)	(0,036)	(0,085)	(0,085)	(0,083)	(0,105)
Mato Grosso do Sul	0,157	0,181	0,204	0,221	0,144	0,113	0,075	-0,107
	(0,026)	(0,026)	(0,023)	(0,036)	(0,034)	(0,036)	(0,036)	(0,043)
Rio de Janeiro	0,146	0,071	0,185	0,182	-0,176	-0,114	-0,293	-0,479
	(0,027)	(0,034)	(0,031)	(0,034)	(0,121)	(0,122)	(0,117)	(0,153)
Rio grande do Sul	0,136	0,118	0,156	0,118	-0,094	-0,200	-0,597	-0,471
	(0,026)	(0,028)	(0,026)	(0,027)	(0,068)	(0,074)	(0,085)	(0,107)
Mato Grosso	0,130	0,194	0,191	0,257	0,157	0,196	0,333	0,017
	(0,026)	(0,028)	(0,027)	(0,029)	(0,039)	(0,038)	(0,045)	(0,053)
Santa Catarina	0,145	0,085	0,147	0,084	0,063	-0,052	-0,161	-0,218
	(0,033)	(0,034)	(0,030)	(0,033)	(0,044)	(0,052)	(0,053)	(0,065)
Paraná	0,120	0,134	0,129	0,141	-0,023	-0,053	0,001	-0,165
	(0,024)	(0,024)	(0,023)	(0,023)	(0,050)	(0,052)	(0,052)	(0,065)
Goiás	0,072	0,158	0,170	0,215	0,170	0,177	0,141	0,003
	(0,024)	(0,027)	(0,025)	(0,025)	(0,029)	(0,029)	(0,030)	(0,034)
Minas Gerais	0,050	0,109	0,127	0,165	0,040	0,055	0,060	-0,042
	(0,020)	(0,023)	(0,022)	(0,022)	(0,041)	(0,042)	(0,041)	(0,052)
Sergipe	-0,097	0,083	0,047	0,104	0,061	0,213	0,937	0,450
	(0,028)	(0,036)	(0,032)	(0,034)	(0,042)	(0,054)	(0,115)	(0,142)
Bahia	-0,123	0,048	-0,008	0,069	-0,039	0,046	0,653	0,252
	(0,023)	(0,030)	(0,029)	(0,038)	(0,059)	(0,060)	(0,105)	(0,131)
Pernambuco	-0,147	-0,018	-0,021	0,059	-0,110	0,059	0,904	0,353
	(0,023)	(0,028)	(0,027)	(0,031)	(0,075)	(0,082)	(0,147)	(0,180)
Alagoas	-0,148	0,025	0,049	0,098	0,074	0,347	1,507	0,733
	(0,028)	(0,035)	(0,032)	(0,038)	(0,050)	(0,074)	(0,177)	(0,219)
Rio Grande do Norte	-0,134	-0,033	-0,036	0,021	-0,017	0,157	1,110	0,603
	(0,028)	(0,033)	(0,029)	(0,035)	(0,046)	(0,057)	(0,143)	(0,178)
Ceará	-0,214	-0,055	-0,139	-0,030	-0,223	-0,100	0,823	0,373
	(0,026)	(0,034)	(0,032)	(0,039)	(0,083)	(0,084)	(0,154)	(0,192)
Paraíba	-0,281	-0,158	-0,228	-0,137	-0,193	0,017	1,012	0,661
	(0,031)	(0,036)	(0,033)	(0,039)	(0,046)	(0,064)	(0,151)	(0,189)
Maranhão	-0,289	-0,099	-0,262	-0,228	-0,172	-0,045	0,949	0,516
	(0,038)	(0,045)	(0,043)	(0,067)	(0,076)	(0,074)	(0,152)	(0,191)
Piauí	-0,450	-0,274	-0,462	-0,441	-0,485	-0,392	0,299	0,363
	(0,041)	(0,048)	(0,046)	(0,059)	(0,074)	(0,073)	(0,123)	(0,148)
Time Dummies	x	x	x	x	x	x	x	x
Cohort Dummies	x	x	x	x	x	x	x	x
Human Capital		x	x	x	x	x	x	x
Participation			x	x	x	x	x	x
HH Characteristics				x	x	x	x	x
Infra-Structure					x	x	x	x
Life Expectance						x	x	x
Infant Mortality							x	x
Sample Size	2166	2166	2166	2166	2166	2166	2166	2166
R2	0,488	0,528	0,619	0,631	0,645	0,651	0,664	0,439

Notes: **Standard Errors in bracckets.**

[1]The state of Espírito Santo is taken as reference

[2]All colluns except (8) include age, age square variable and initial income.

Table 4: First Differences - Dependent Variable is $\Delta \ln(w)$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0,162	-0,373	-0,031	0,427	-11,309	-6,185	-9,186	-4,678
	(0,444)	(0,389)	(0,394)	(0,423)	(2,518)	(2,327)	(2,906)	(1,592)
age	0,036	-0,001	0,008	-0,002	0,0005	0,003	-0,034	0,004
	(0,009)	(0,009)	(0,010)	(0,010)	(0,010)	(0,010)	(0,013)	(0,010)
(age)2	-0,00005	0,0001	-0,00002	0,00005	0,0003	0,000003	0,0005	-0,000009
	(0,0001)	(0,0001)	(0,0001)	(0,0001)	(0,0001)	(0,0001)	(0,0001)	(0,00009)
Educ_head	0,093	0,074	0,096	0,085	0,089	0,090	0,061	0,055
	(0,017)	(0,021)	(0,016)	(0,015)	(0,015)	(0,015)	(0,019)	(0,015)
Sexo_head	0,940	0,132	0,205	0,154	0,181	0,161	0,050	0,215
	(0,204)	(0,246)	(0,179)	(0,175)	(0,176)	(0,171)	(0,221)	(0,164)
Educ_part	-0,009	-0,0002	0,002	0,002	0,002	0,015	0,0001	-0,019
	(0,021)	(0,020)	(0,019)	(0,019)	(0,019)	(0,019)	(0,024)	(0,019)
Child_educa	0,505	0,193	0,152	0,152	0,139	0,163	-0,069	0,164
	(0,068)	(0,067)	(0,067)	(0,065)	(0,064)	(0,171)	(0,080)	(0,068)
Part_head	-	1,916	1,977	2,030	2,032	2,074	1,013	1,906
		(0,124)	(0,128)	(0,127)	(0,125)	(0,124)	(0,142)	(0,126)
Part_part	-	-0,083	-0,036	0,003	-0,020	-0,013	-0,015	-0,240
		(0,100)	(0,097)	(0,095)	(0,095)	(0,095)	(0,123)	(0,094)
Part_child	-	0,975	0,990	1,056	1,051	1,070	0,416	0,928
		(0,112)	(0,107)	(0,106)	(0,105)	(0,102)	(0,129)	(0,111)
Stove	-	-	-0,519	-0,252	-0,127	0,018	0,180	-0,105
			(0,143)	(0,136)	(0,134)	(0,135)	(0,173)	(0,092)
Fridge	-	-	0,468	0,615	0,606	0,439	0,523	0,497
			(0,105)	(0,136)	(0,133)	(0,134)	(0,172)	(0,101)
HH dens.	-	-	-0,271	-0,303	-0,326	-0,363	0,040	-0,280
			(0,069)	(0,067)	(0,066)	(0,066)	(0,086)	(0,060)
Sewage	-	-	-	-0,030	-0,199	-0,109	-0,056	-0,150
				(0,141)	(0,148)	(0,148)	(0,179)	(0,054)
Metrop.	-	-	-	0,373	0,342	0,454	0,391	0,068
				(0,152)	(0,153)	(0,147)	(0,192)	(0,027)
Urban	-	-	-	0,060	0,167	0,252	0,200	0,202
				(0,117)	(0,120)	(0,119)	(0,163)	(0,105)
Light	-	-	-	-0,774	-0,858	-0,559	-0,483	-0,606
				(0,142)	(0,144)	(0,141)	(0,187)	(0,130)
Garbage	-	-	-	0,485	0,438	0,294	-0,056	0,654
				(0,101)	(0,102)	(0,103)	(0,179)	(0,069)
Life exp.	-	-	-	-	2,841	2,396	2,276	0,598
					(0,622)	(0,580)	(0,713)	(0,362)
Infant mort	-	-	-	-	-	-0,971	-0,273	0,059
						(0,122	(0,153)	(0,038)
Rain fall	-	-	-	-	-	-	-	0,139
								(0,035)
Latitude	-	-	-	-	-	-	-	0,152
								(0,024)
Temp	-	-	-	-	-	-	-	0,336
								(0,045)
Time dummies	yes	yes	Yes	yes	yes	yes	yes	yes
State dummies*	yes	yes	Yes	yes	yes	yes	yes	no
Cohort dummies	yes	yes	Yes	yes	yes	yes	yes	yes
R2	0,528	0,619	0,631	0.645	0.651	0,664	0,439	0.612
Sample Size	2166	2166	2166	2166	2166	2166	2166	2166

Notes: **Standard Errors in bracckets.**

[1] The state of Espírito Santo is taken as reference

[2] All colluns except (7) include initial income.

Table 5: Variable description

	Code	Brazil		NE and CO		South and SE	
		Avg	SD	Avg	SD	Avg	SD
Dependent Variable:							
monthly income in the main occupation of household head		71103	156911	56522	121330	96097	201583
Family:							
gender of the household head (male = 1; female = 0)	Sexo_head	0,835	0,079	0,832	0,077	0,840	0,081
Education: household head	Educ_head	3,858	1,654	3,199	1,367	4,987	1,486
(years) spouse (or husband)	Educ_part	3,151	1,429	2,747	1,305	3,845	1,366
Participation household head (previous week)	Part_head	0,847	0,161	0,857	0,145	0,830	0,183
in labor force spouse (or husband)	Part_part	0,304	0,115	0,298	0,111	0,315	0,119
(yes=1; no=0) children (average, yes=1; no=0)	Part_child	0,246	0,171	0,238	0,161	0,260	0,187
Household:							
Density – occupants per room	HH dens.	0,913	0,206	0,982	0,203	0,796	0,152
Proprietorship of house (owned = 1; not owned = 0)		0,690	0,143	0,702	0,139	0,669	0,146
Availability of oven (yes = 1; no = 0)	Stove	0,915	0,110	0,876	0,121	0,983	0,016
Availability of refrigerator (yes = 1; no = 0)	Fridge	0,572	0,208	0,457	0,147	0,771	0,136
Electricity (supplied with electricity = 1; not supplied = 0)	Light	0,769	0,166	0,694	0,152	0,898	0,092
Water (supplied by the public system = 1; not supplied = 0)	Water	0,621	0,185	0,522	0,140	0,792	0,116
Sewage (served by the public system = 1; not served = 0)	Sewage	0,484	0,170	0,387	0,108	0,650	0,122
Garbage (served by the public system = 1; not served = 0)	Garbage	0,497	0,191	0,418	0,163	0,633	0,157
Geographical:							
Urban/rural (urban = 1; rural = 0)	Metrop.	0,164	0,227	0,082	0,149	0,303	0,266
Metropolitan region (metropolitan = 1; non-metropolitan=0)	Urban	0,675	0,140	0,618	0,121	0,773	0,114
	Life exp.	61,199	4,001	59,694	3,640	63,778	3,196
	Infant mort	65,473	35,407	82,187	34,048	36,821	10,758
Distance from the sea (from the state's capitals) - km		226,252	203,941	267,627	240,303	155,323	77,182
Average temperature in the Winter - Celsius degrees	Temp	19,892	4,334	21,778	3,738	16,661	3,241
Altitude – m		328,073	164,765	269,625	114,701	428,269	187,772
Longitude – degrees	Latitude	-13,315	7,094	-8,839	3,049	-20,987	5,240
Rainfall – mm/year	Rain fall	103,039	24,553	92,485	22,393	121,133	16,079

Tabela 6a

Variable	São Paulo		Rio de Janeiro		Minas Gerais		Paraná		Santa Catarina		Rio Grande do Sul		Espírito santo		Maranhão		Piaui		Ceará
--------	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg
rendapc	120970	246894	117826	236551	70110	142470	84753	171656	94613	205678	108813	227253	75598	152146	34395	64530	32334	63218	43465
Sexo_head	0,836	0,076	0,797	0,087	0,828	0,084	0,858	0,066	0,875	0,076	0,836	0,078	0,849	0,076	0,835	0,067	0,830	0,063	0,846
Educ_head	5,551	1,255	6,292	1,050	4,239	1,246	4,363	1,466	4,860	1,445	5,213	1,322	4,393	1,385	2,340	1,039	2,329	1,155	2,744
Educ_part	4,080	1,308	4,344	1,199	3,408	1,312	3,402	1,378	4,003	1,360	4,132	1,333	3,542	1,356	2,108	1,057	2,156	1,145	2,481
Part_head	0,813	0,204	0,791	0,218	0,830	0,165	0,856	0,156	0,836	0,182	0,842	0,173	0,840	0,168	0,898	0,108	0,879	0,122	0,868
Part_part	0,261	0,099	0,274	0,090	0,262	0,106	0,322	0,106	0,382	0,120	0,391	0,119	0,314	0,112	0,380	0,109	0,334	0,130	0,335
Part_child	0,259	0,190	0,210	0,160	0,255	0,185	0,293	0,193	0,295	0,204	0,244	0,168	0,267	0,193	0,252	0,155	0,248	0,165	0,232
HH dens.	0,834	0,153	0,785	0,127	0,796	0,136	0,861	0,168	0,744	0,153	0,741	0,146	0,810	0,138	1,193	0,195	1,092	0,229	1,062
Stove	0,988	0,011	0,984	0,010	0,983	0,011	0,978	0,017	0,976	0,026	0,986	0,010	0,985	0,017	0,634	0,125	0,697	0,147	0,906
Fridge	0,881	0,068	0,878	0,065	0,601	0,101	0,690	0,114	0,838	0,078	0,816	0,076	0,690	0,118	0,302	0,088	0,327	0,106	0,362
Light	0,963	0,075	0,973	0,019	0,806	0,101	0,853	0,096	0,928	0,039	0,899	0,053	0,865	0,089	0,507	0,135	0,484	0,124	0,601
Water	0,934	0,033	0,869	0,062	0,742	0,072	0,751	0,095	0,734	0,144	0,793	0,086	0,723	0,092	0,294	0,068	0,380	0,077	0,367
Sewage	0,851	0,041	0,750	0,044	0,681	0,046	0,572	0,032	0,506	0,061	0,549	0,052	0,638	0,048	0,246	0,040	0,200	0,041	0,300
Garbage	0,890	0,032	0,722	0,065	0,527	0,082	0,619	0,104	0,543	0,132	0,654	0,085	0,478	0,084	0,134	0,068	0,189	0,070	0,320
Metrop.	0,514	0,030	0,804	0,028	0,220	0,029	0,246	0,024	-	-	0,340	0,029	-	-	-	-	-	-	0,352
Urban	0,923	0,013	0,941	0,016	0,739	0,036	0,717	0,056	0,654	0,065	0,741	0,049	0,695	0,062	0,373	0,058	0,496	0,081	0,603
Life exp.	63,78	3,31	62,27	2,72	62,74	3,38	63,71	3,00	65,38	2,83	65,46	2,72	63,10	2,91	59,84	2,17	59,63	2,79	59,02
Infant mort	36,43	9,10	38,11	11,94	41,42	10,50	41,98	10,58	34,46	9,33	26,07	6,27	39,28	7,95	97,08	14,03	73,54	14,83	103,4[illegible]
Temp	16,82	-	18,32	-	18,26	-	14,12	-	13,46	-	12,89	-	22,76	-	25,99	-	25,23	-	24,03
Latitude	-21,27	-	-21,16	-	-18,17	-	-22,85	-	-26,31	-	-26,96	-	-10,19	-	-5,03	-	-6,93	-	-4,71
Rain fall	127,98	-	113,36	-	119,45	-	132,17	-	143,90	-	122,44	-	88,63	-	116,92	-	95,50	-	80,28

Tabela 6b

Variable	Rio Grande do Norte		Pariba		Pernambuco		Alagoas		Sergipe		Bahia		Mato Grosso do Sul		Mato Graosso		Goiás	
	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD	Avg	SD
rendapc	50877	104970	43305	88464	55808	108992	50889	111278	53628	109881	57743	114035	90099	182990	80084	156488	85640	178365
Sexo_head	0,833	0,085	0,814	0,083	0,808	0,077	0,824	0,090	0,805	0,091	0,823	0,072	0,861	0,061	0,879	0,052	0,831	0,074
Educ_head	3,276	1,196	3,236	1,279	3,479	1,031	2,780	1,132	3,084	1,199	3,071	1,088	4,284	1,467	3,752	1,587	4,016	1,545
Educ_part	3,044	1,328	3,050	1,398	2,879	1,170	2,239	1,135	2,666	1,217	2,467	1,050	3,420	1,366	3,120	1,389	3,331	1,424
Part_head	0,838	0,160	0,831	0,146	0,824	0,159	0,821	0,178	0,843	0,160	0,869	0,129	0,874	0,129	0,889	0,131	0,847	0,156
Part_part	0,290	0,105	0,286	0,113	0,288	0,087	0,271	0,100	0,313	0,109	0,304	0,090	0,273	0,114	0,245	0,103	0,256	0,102
Part_child	0,218	0,158	0,217	0,146	0,230	0,154	0,236	0,156	0,236	0,165	0,229	0,157	0,247	0,168	0,260	0,176	0,255	0,172
HH dens.	0,977	0,173	0,946	0,179	0,938	0,159	0,994	0,180	0,962	0,186	0,952	0,159	0,842	0,139	0,976	0,195	0,849	0,167
Stove	0,867	0,063	0,940	0,027	0,938	0,024	0,845	0,070	0,923	0,035	0,892	0,037	0,967	0,019	0,925	0,055	0,972	0,013
Fridge	0,457	0,110	0,403	0,101	0,468	0,091	0,442	0,112	0,497	0,130	0,417	0,074	0,669	0,109	0,553	0,126	0,584	0,120
Light	0,784	0,108	0,734	0,106	0,785	0,079	0,735	0,111	0,751	0,119	0,669	0,085	0,820	0,103	0,670	0,124	0,788	0,106
Water	0,578	0,066	0,600	0,067	0,595	0,077	0,500	0,078	0,593	0,091	0,510	0,057	0,691	0,117	0,569	0,103	0,584	0,102
Sewage	0,418	0,068	0,428	0,053	0,452	0,056	0,352	0,062	0,407	0,066	0,372	0,053	0,505	0,021	0,443	0,062	0,516	0,060
Garbage	0,560	0,090	0,492	0,079	0,461	0,075	0,455	0,110	0,473	0,098	0,357	0,058	0,600	0,105	0,475	0,128	0,498	0,106
Metrop.	-	-	-	-	0,410	0,038	-	-	-	-	0,224	0,040	-	-	-	-	-	-
Urban	0,665	0,047	0,651	0,050	0,720	0,041	0,588	0,070	0,613	0,101	0,579	0,054	0,766	0,054	0,638	0,085	0,727	0,047
Life exp.	58,45	4,07	57,53	3,55	58,84	2,76	56,71	2,76	59,07	3,41	60,52	2,92	63,06	3,26	61,46	3,15	62,20	3,34
Infant mort	107,19	27,67	113,48	25,94	100,77	22,36	122,99	17,54	79,95	14,49	70,91	11,61	37,02	9,51	41,80	8,29	38,07	9,82
Temp	-	-	22,84	-	21,97	-	23,63	-	22,76	-	18,69	-	13,04	-	21,74	-	16,29	-
Latitude	-	-	-6,83	-	-8,05	-	-8,67	-	-10,19	-	-10,84	-	-14,28	-	-12,82	-	-12,04	-
Rain fall	-	-	67,76	-	63,46	-	91,10	-	88,63	-	76,33	-	84,08	-	146,85	-	113,66	-

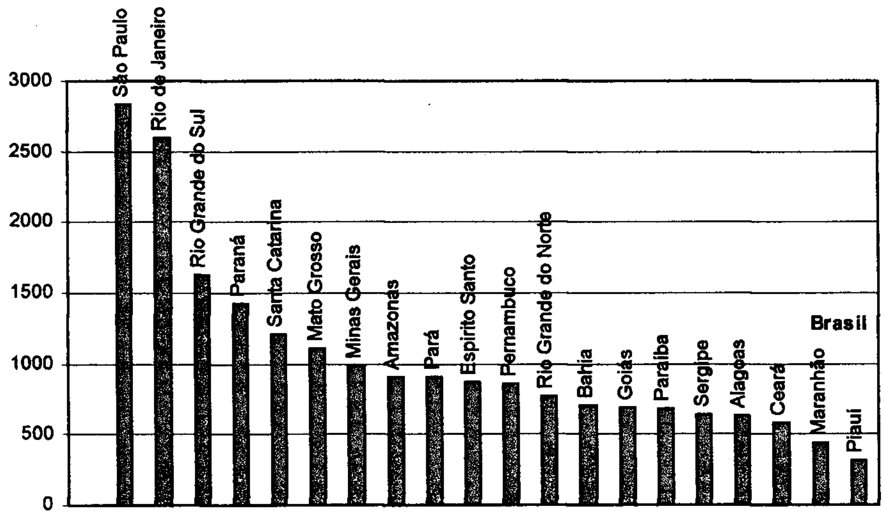


Figura 1: PIB per capita dos Estados brasileiros no ano de 1960

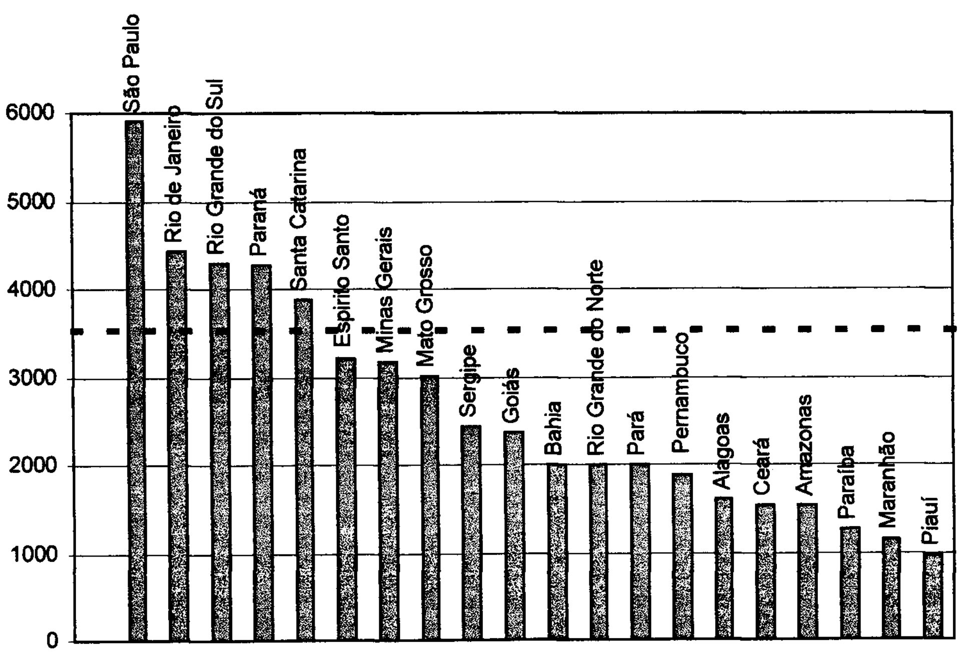
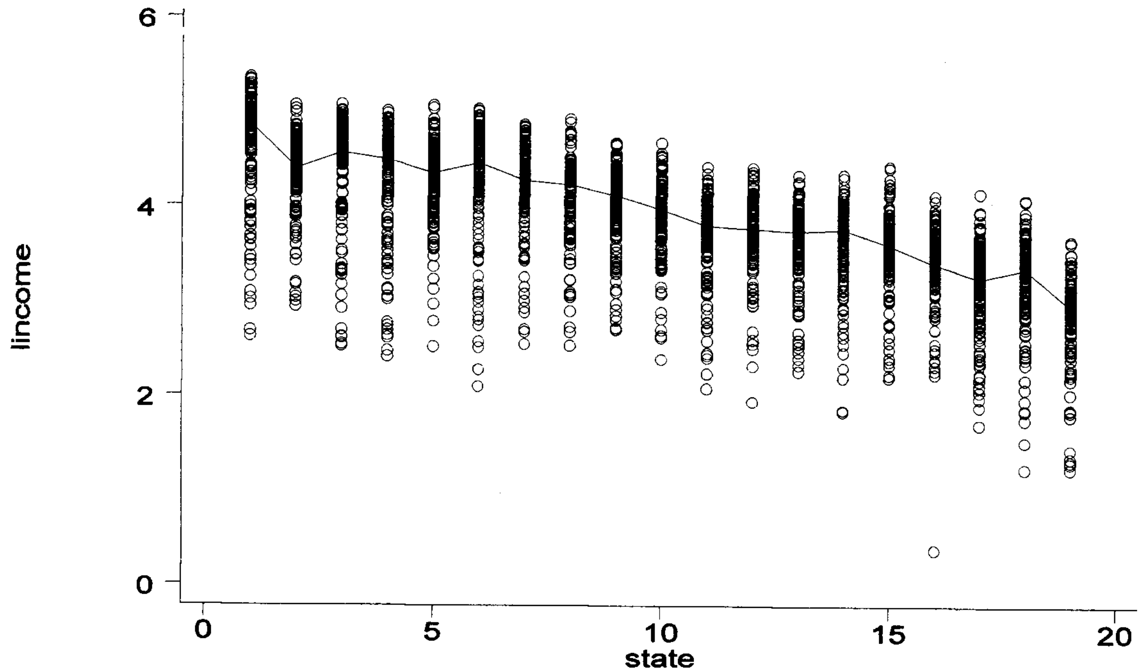
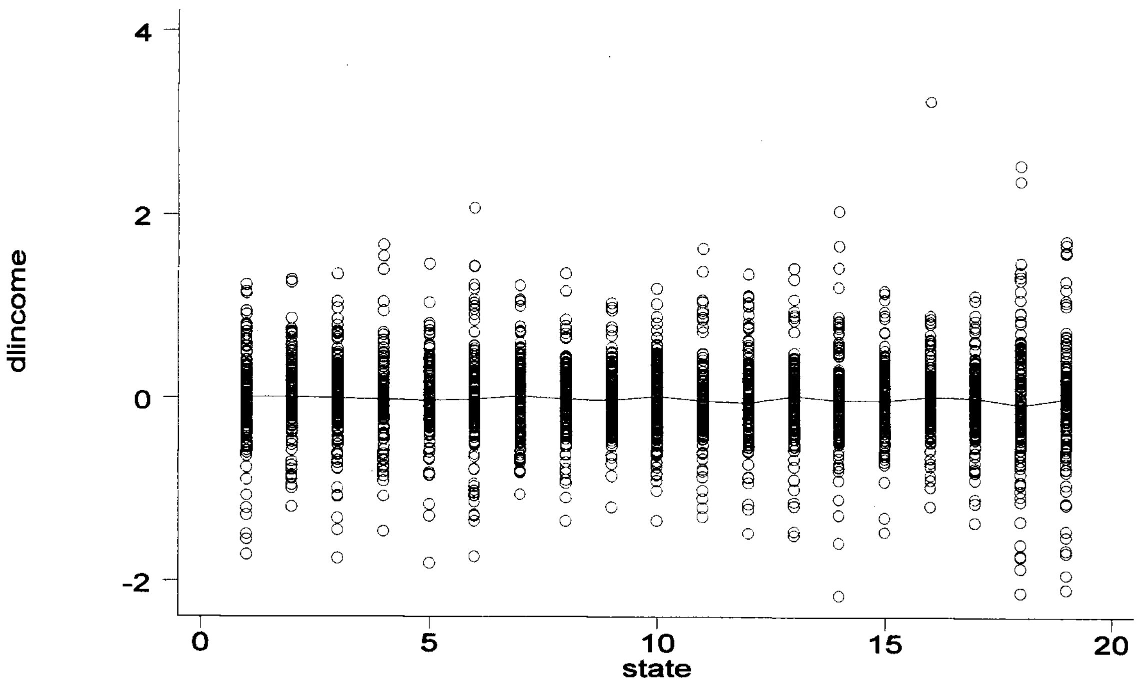


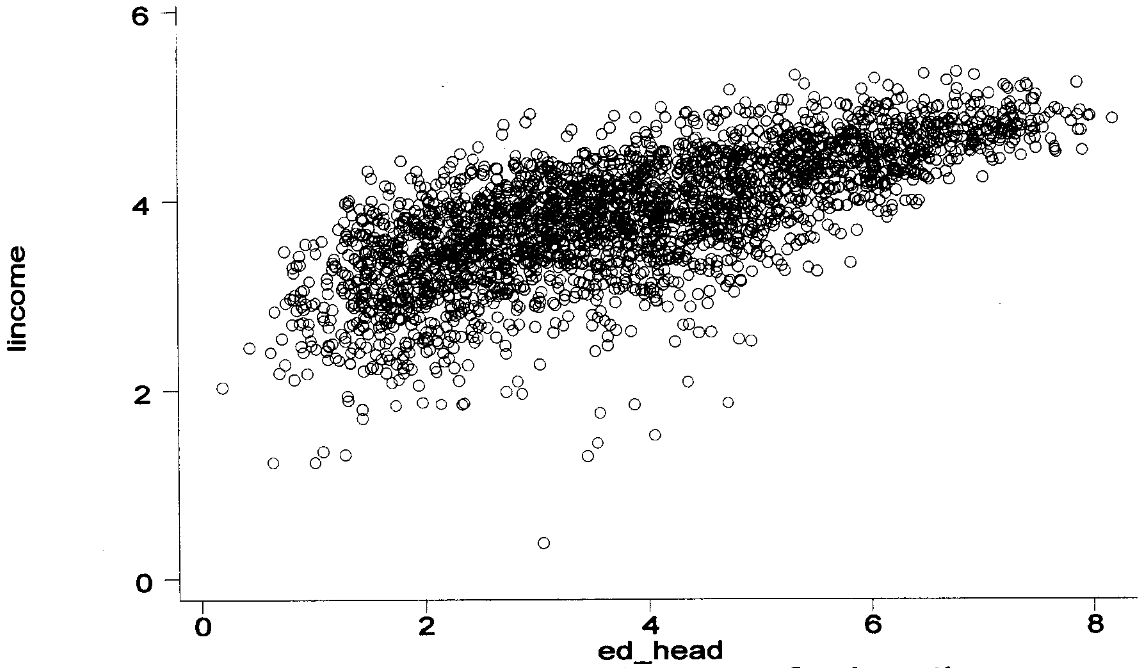
Figura 2: PIB per capita dos Estados brasileiros no ano de 1995



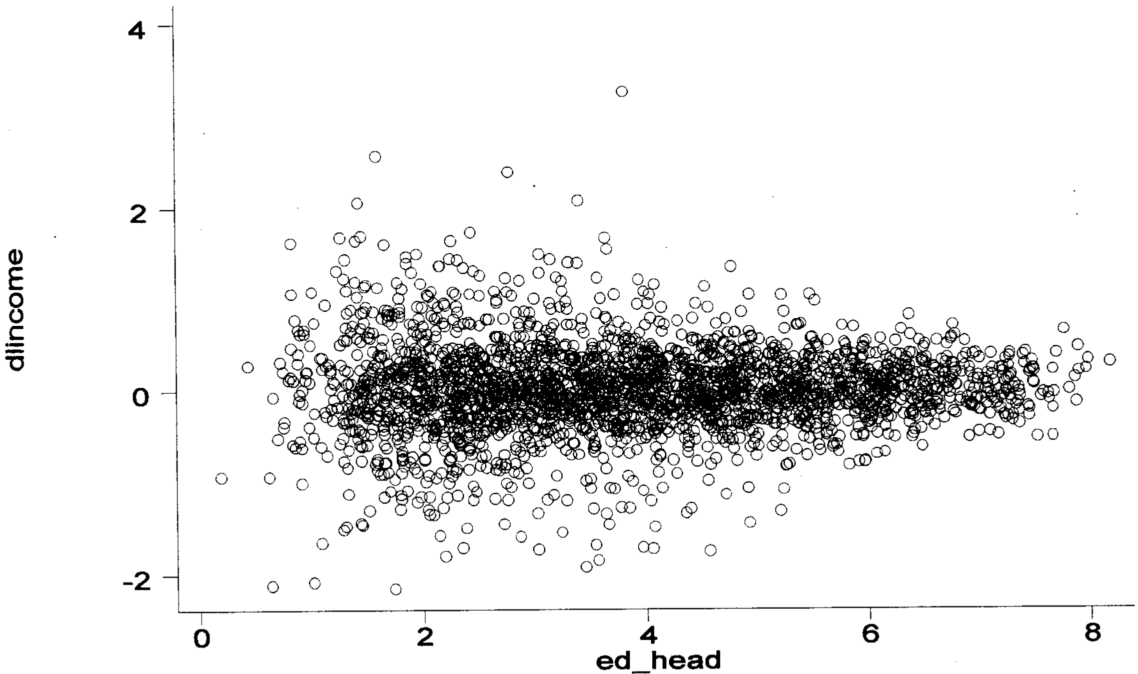
graph 3: hh income and states



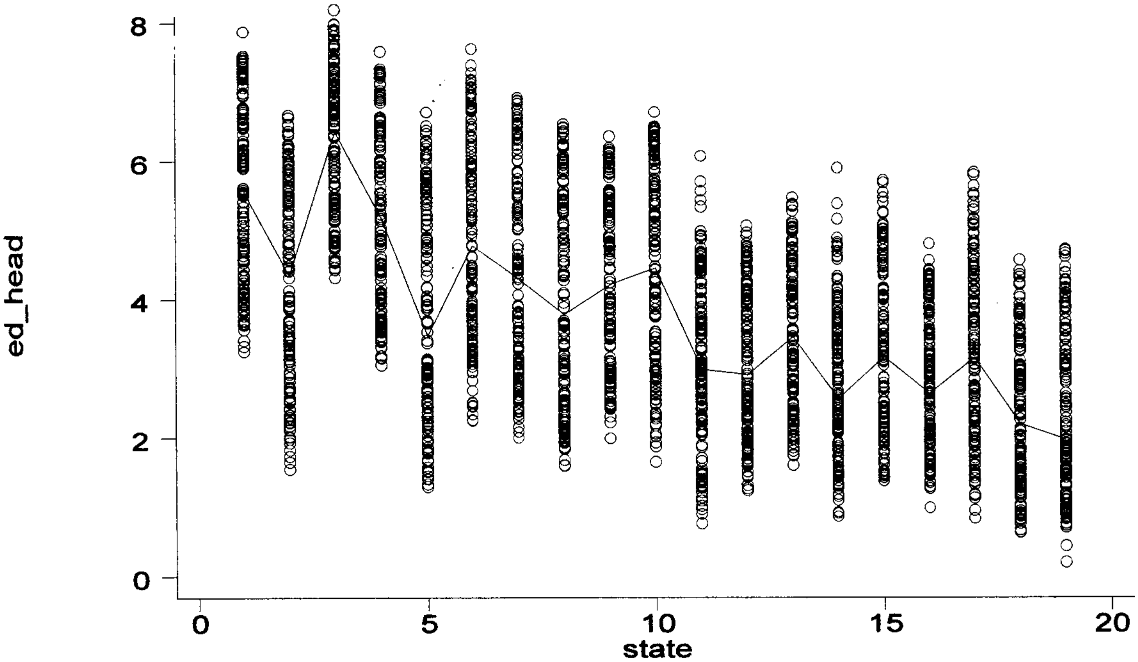
graph 4: hh dincome and states



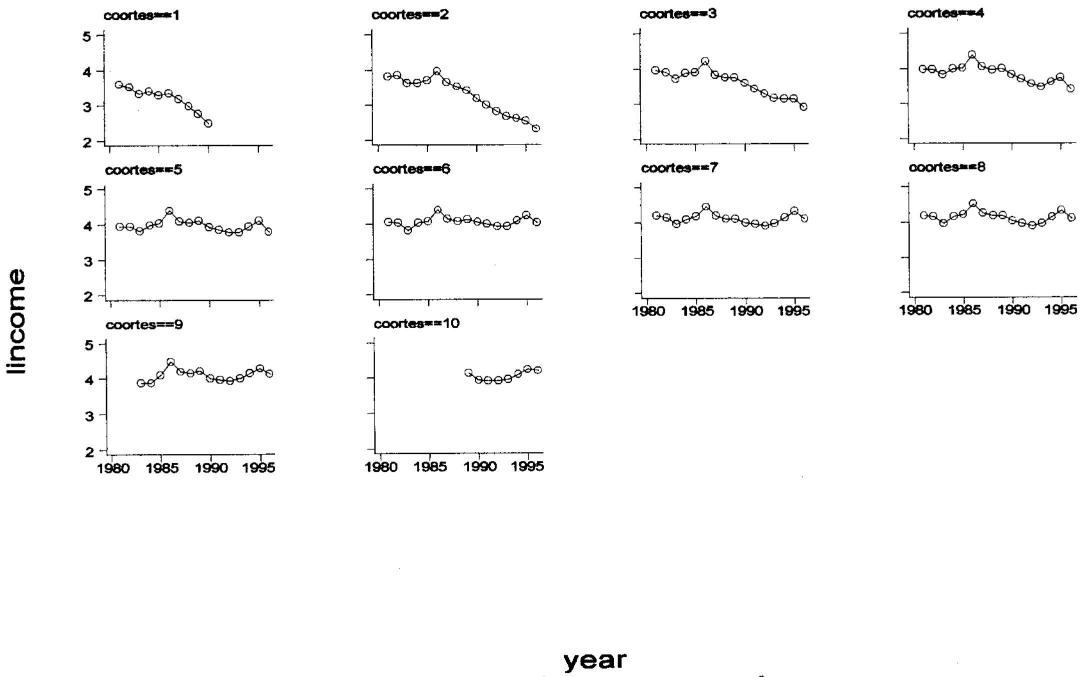
graph 5: hh income and years of education



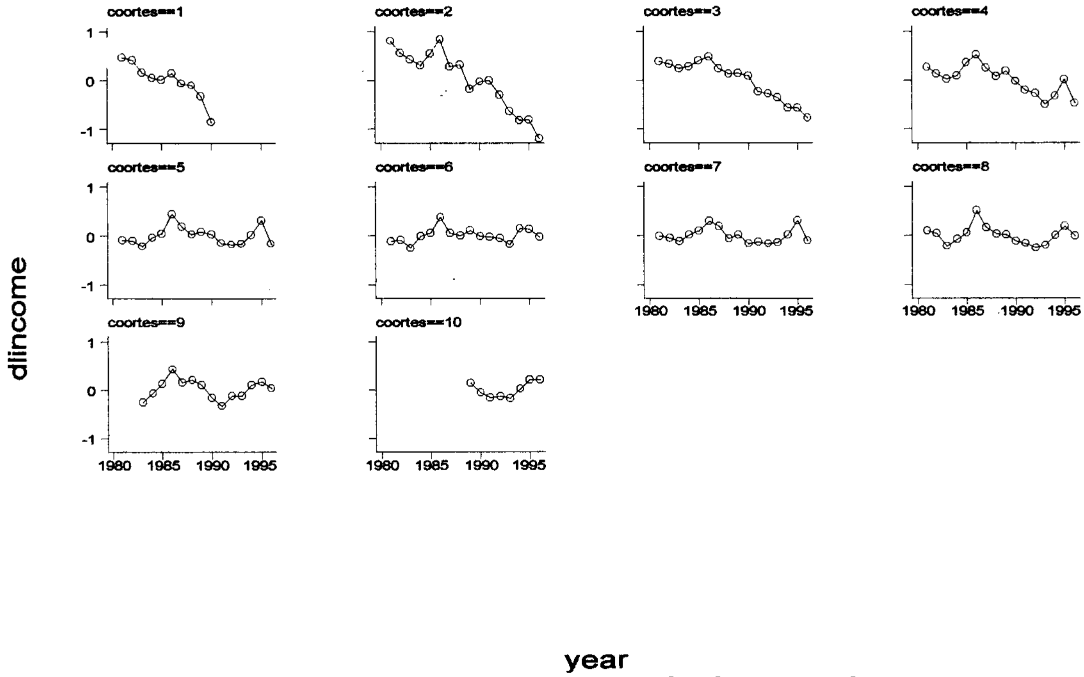
graph 6: hh income variation and years education



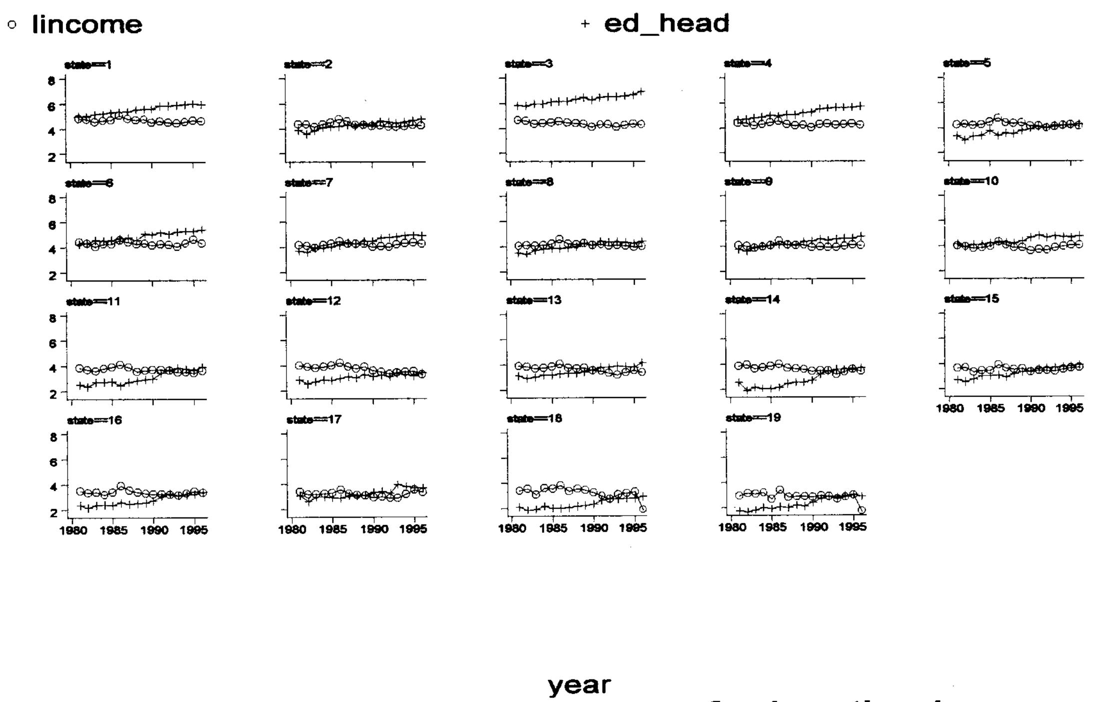
graph 7: years of education by state



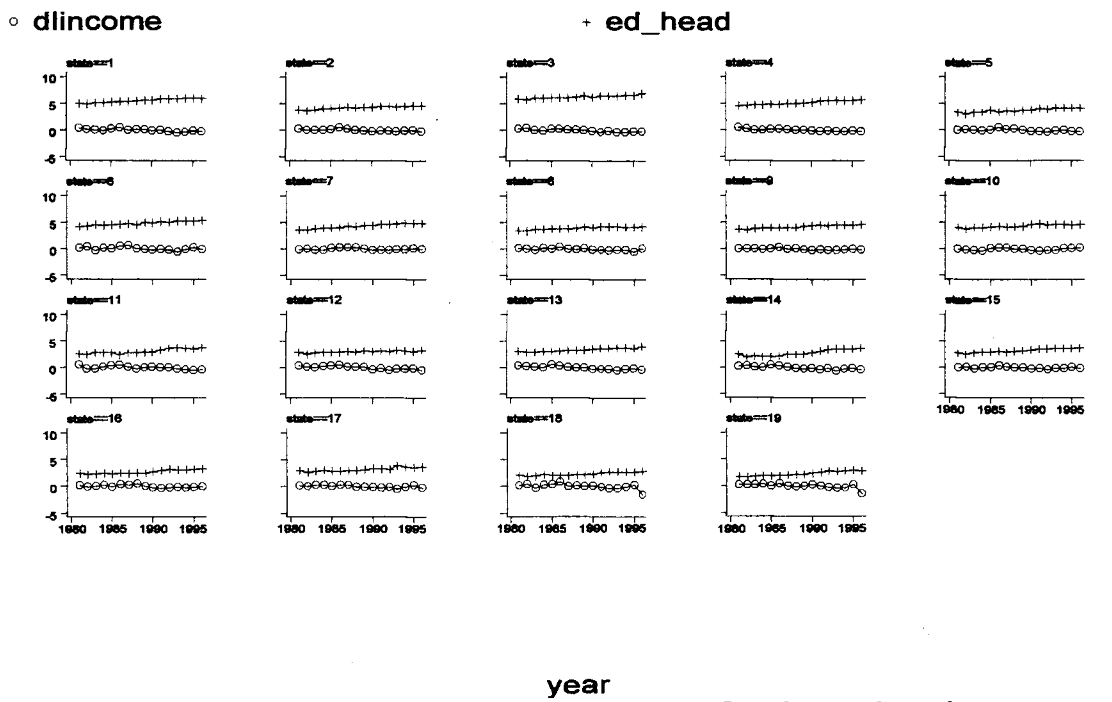
graph 8: hh income and year



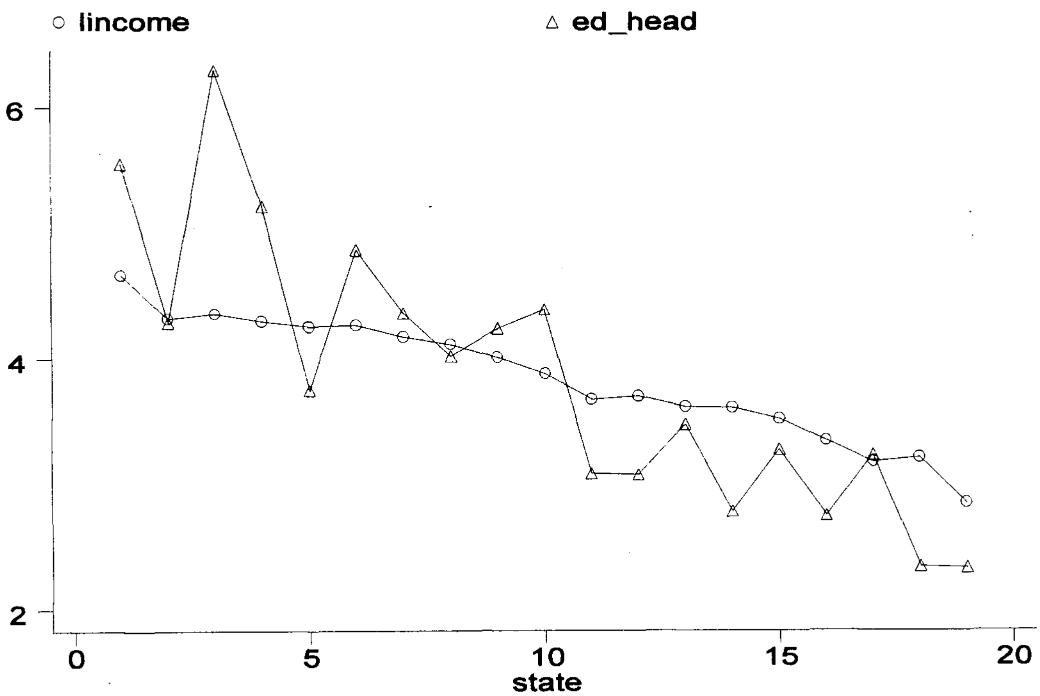
graph 9: hh income variation and year



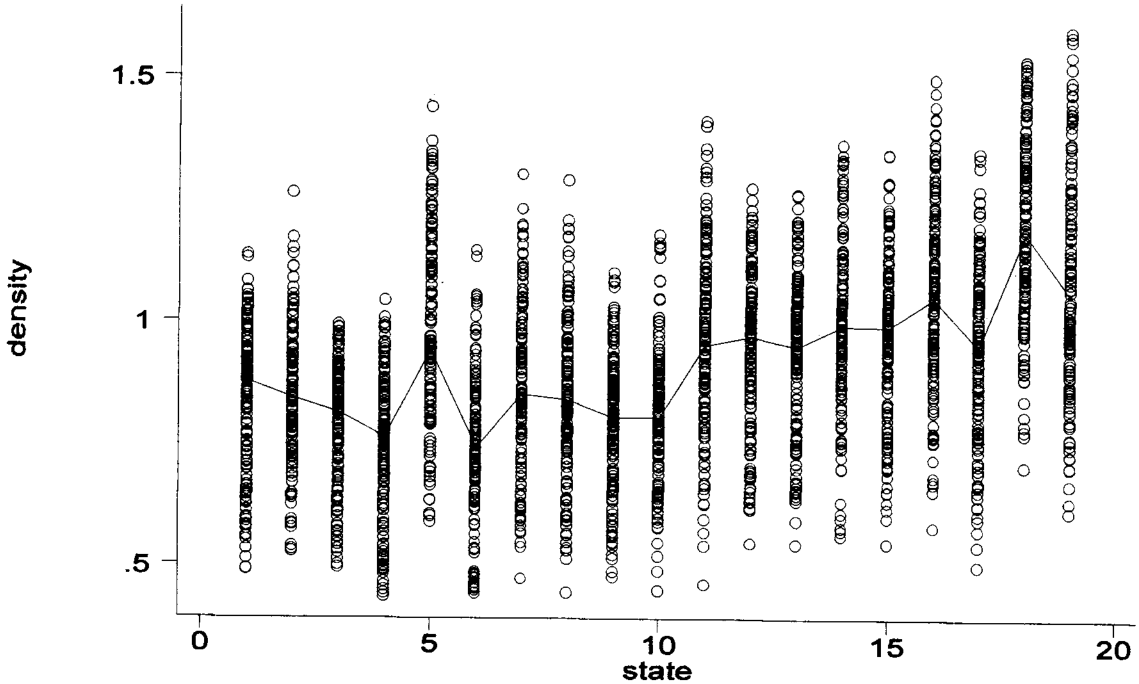
graph 10: hh income and years of education by years



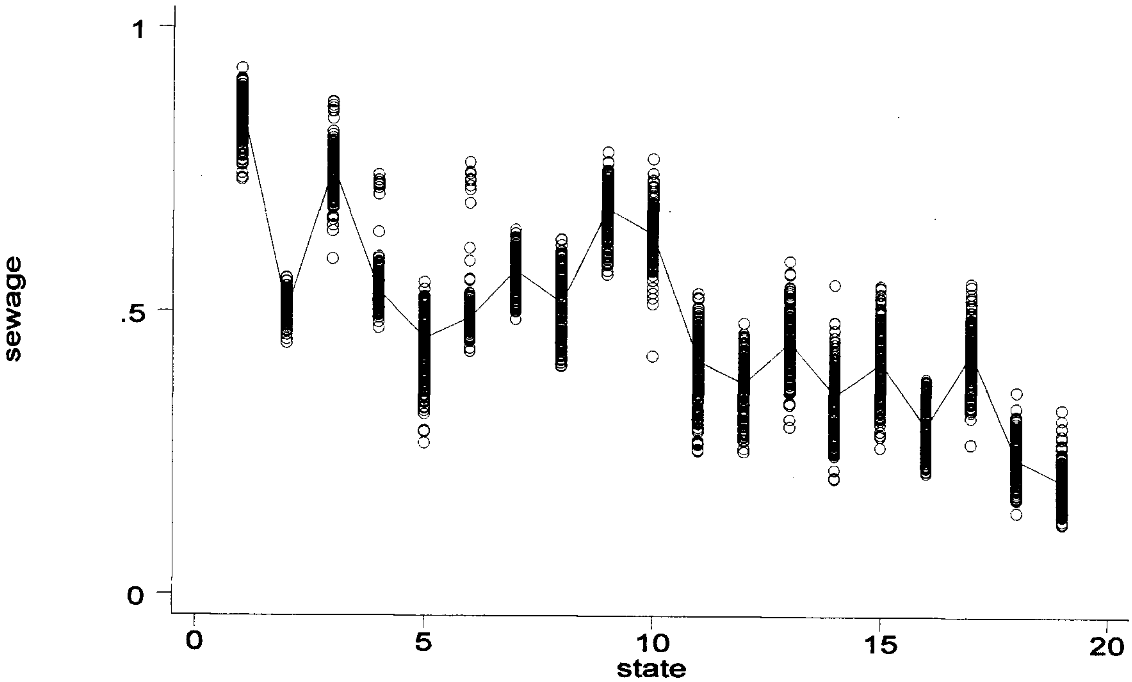
graph 11: hh dincome and years of education by years



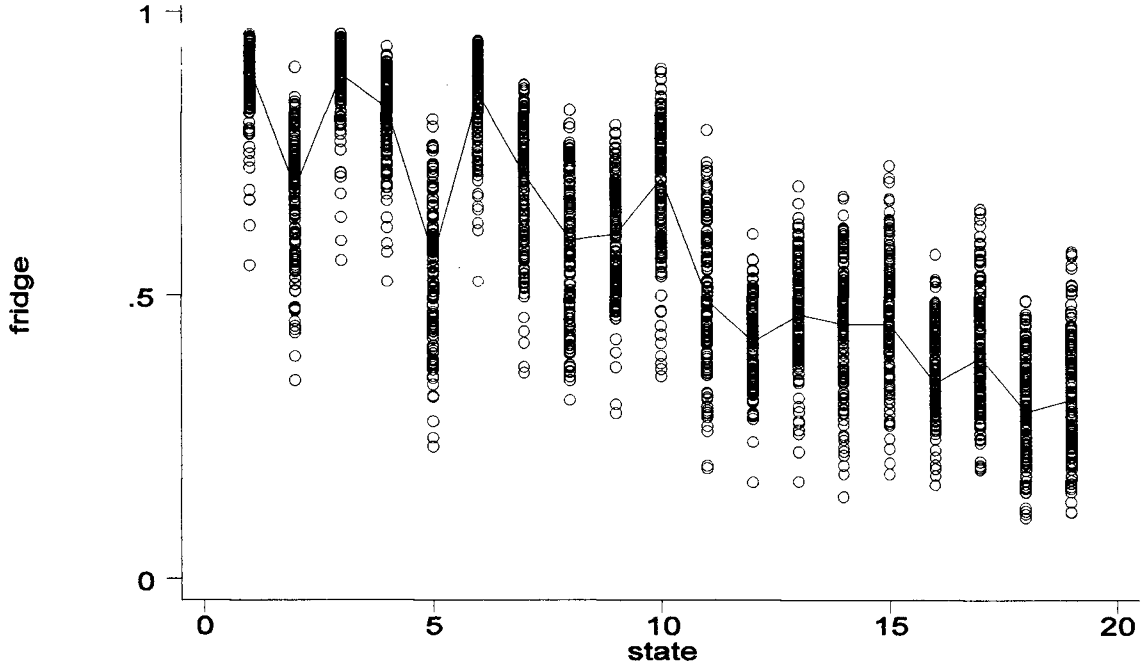
graph 12: hh income and years of education by states



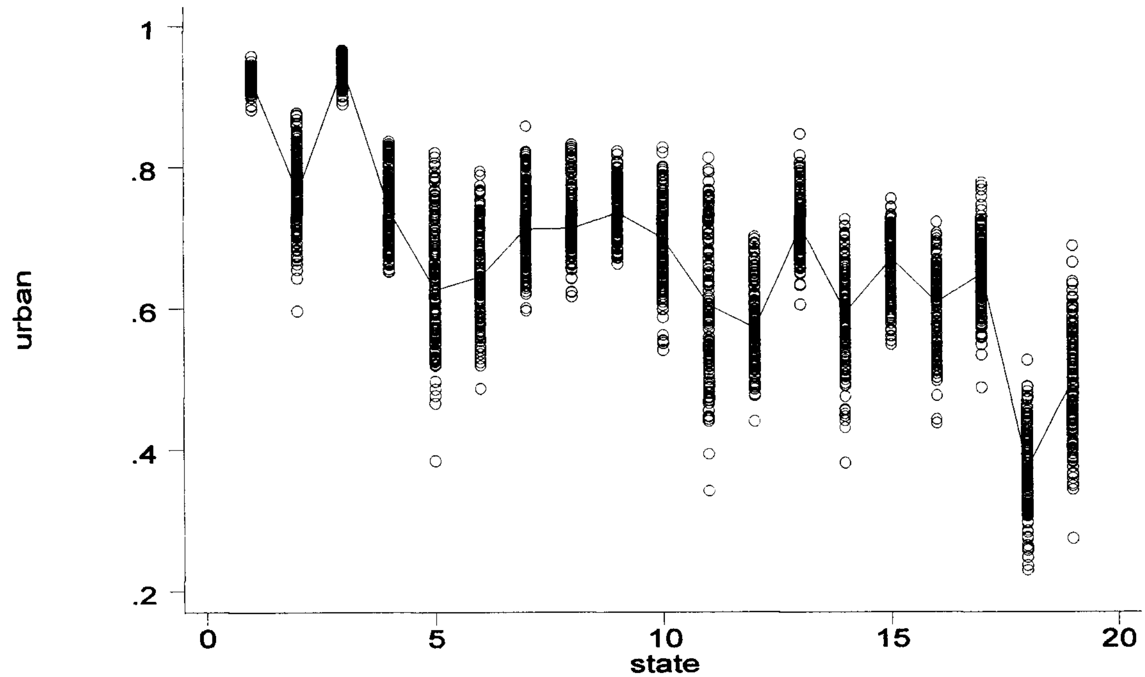
graph 13: hh density by states



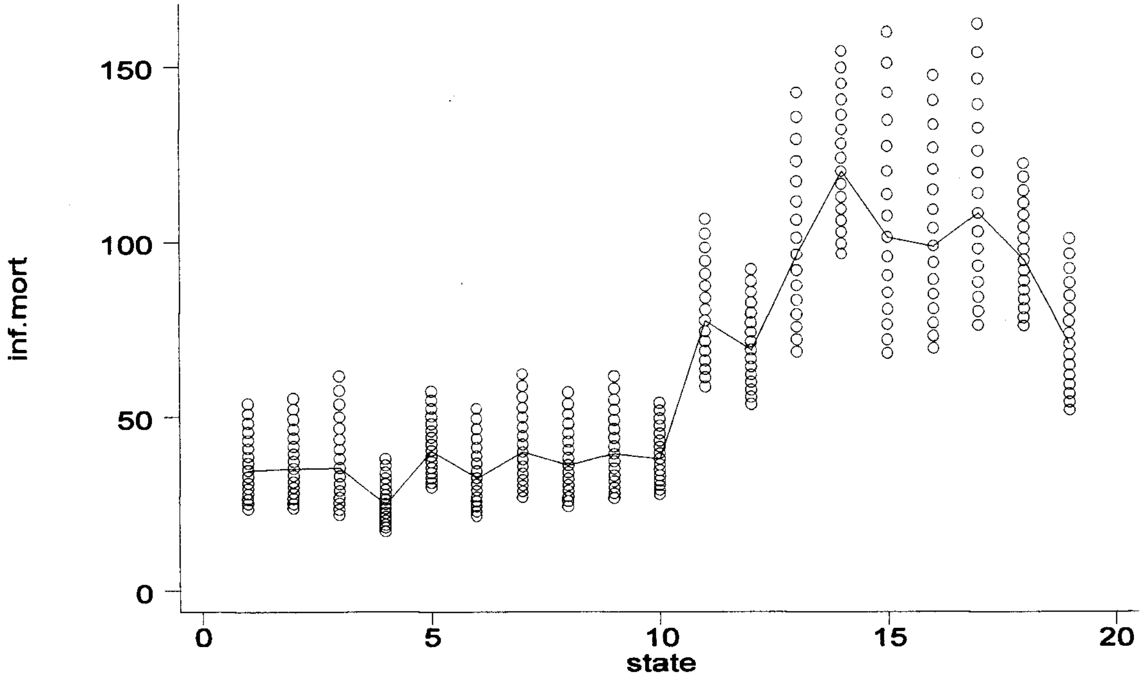
graph 14: public sewage service by states



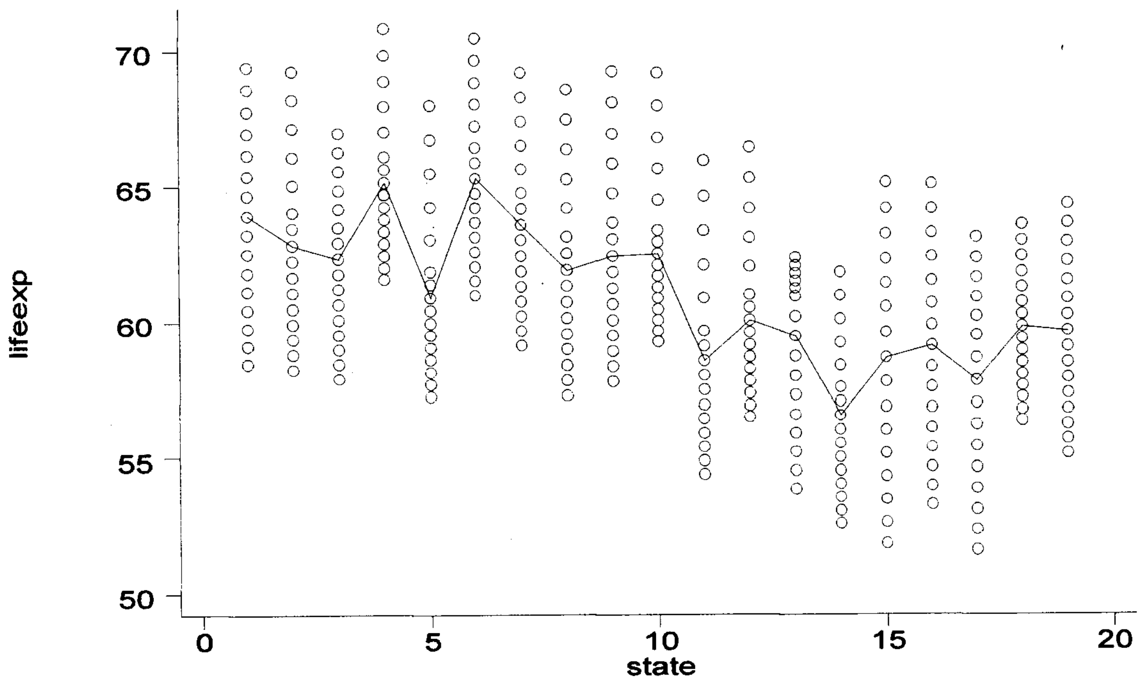
graph 15: fridge by states



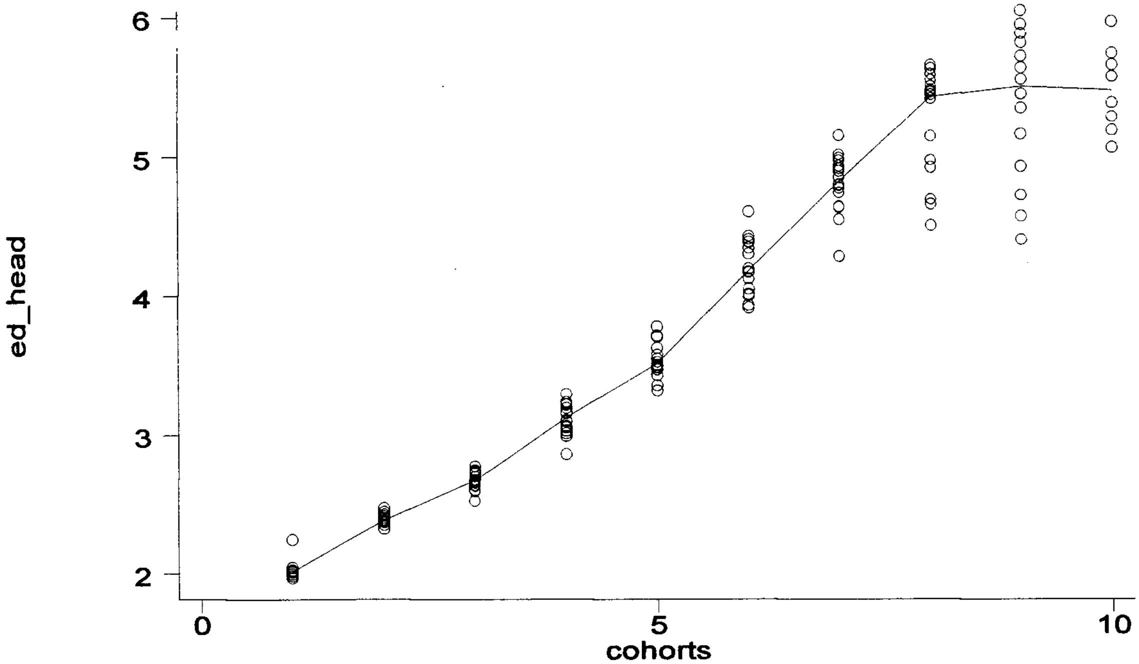
graph 16: urban by states



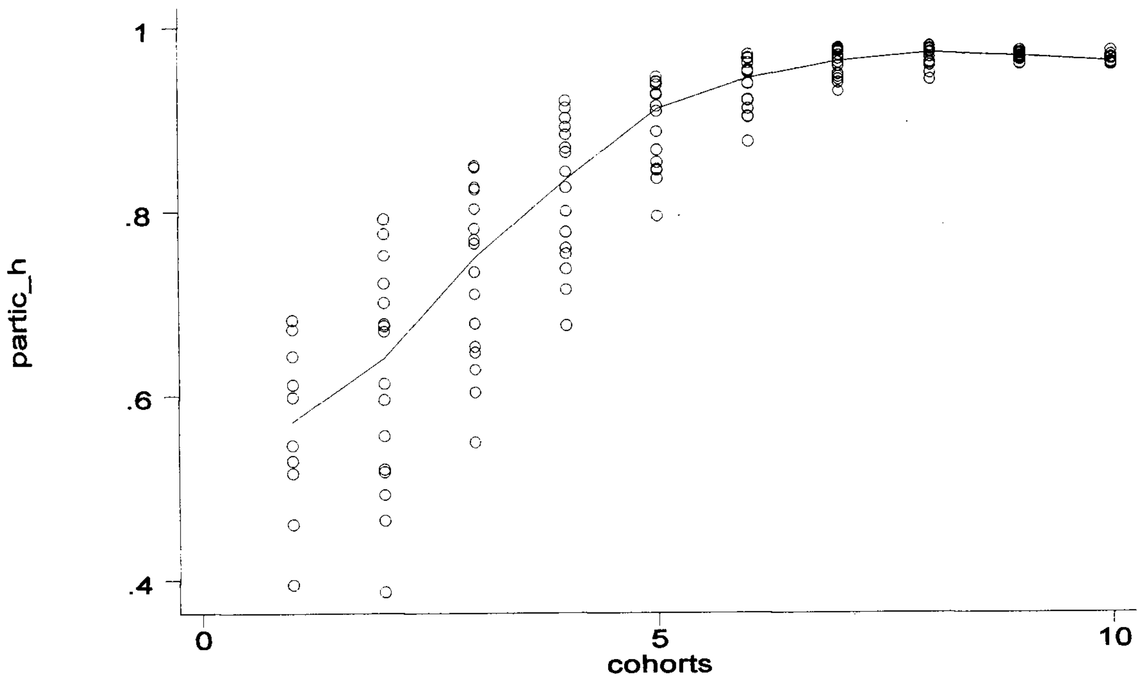
graph 17: infant mortality by states



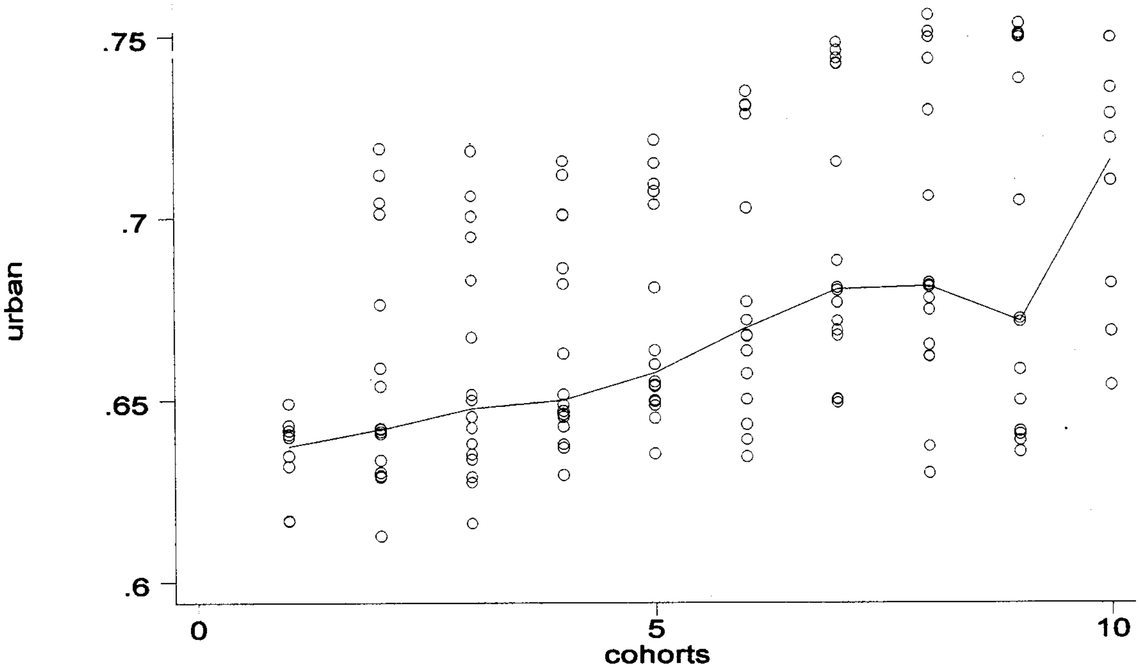
graph 18: life expectation by states



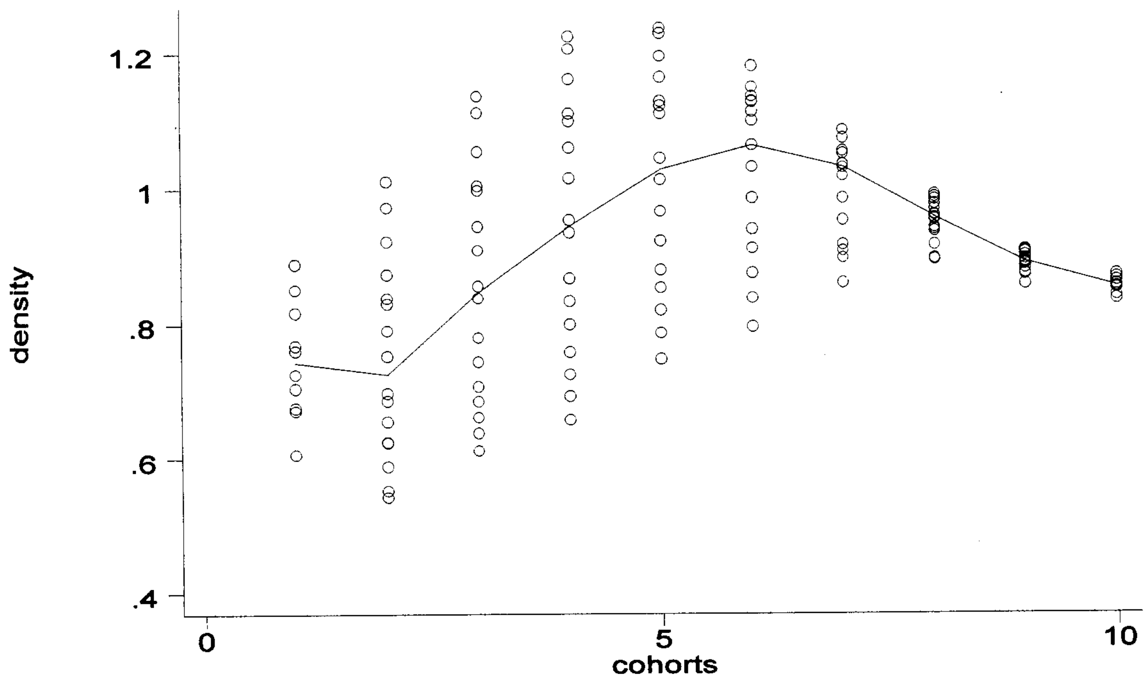
graph 19: hh education across cohorts



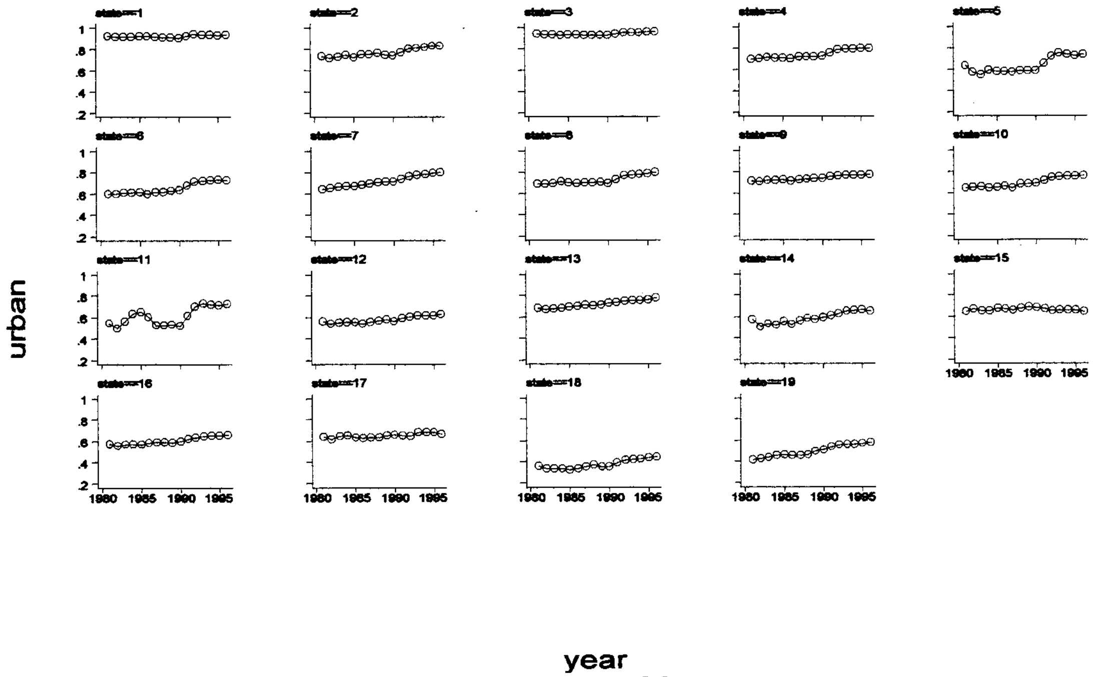
graph 20: hh participation rate across cohorts



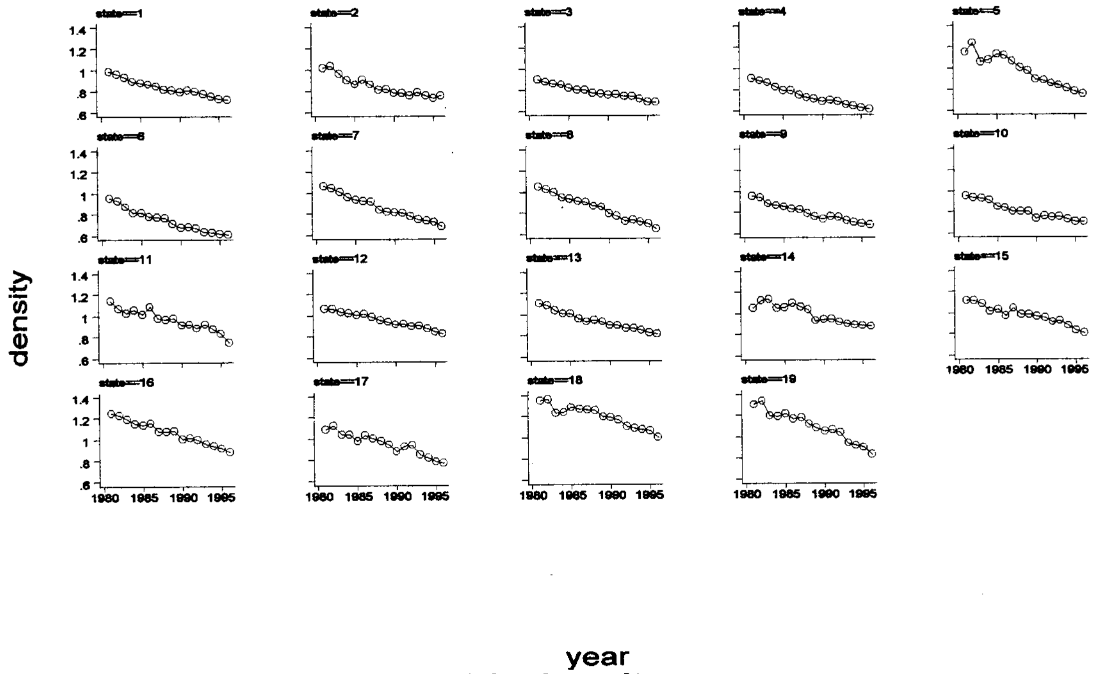
graph 21: hh urban % across cohorts



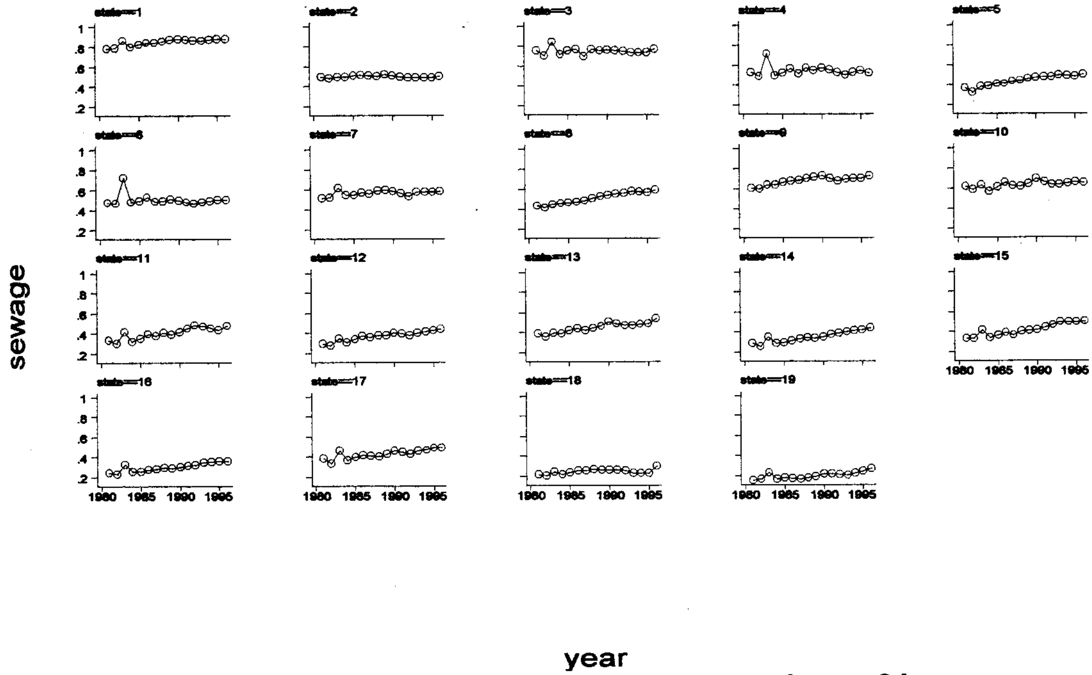
graph 22: hh density across cohorts



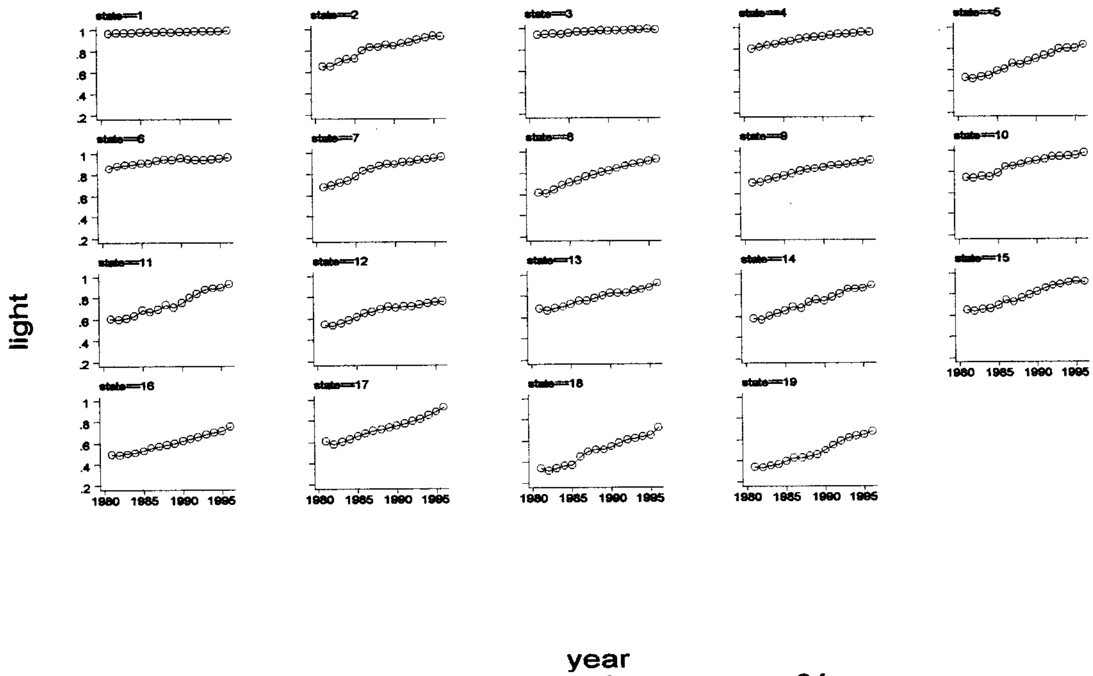
graph 23: hh urban % across year



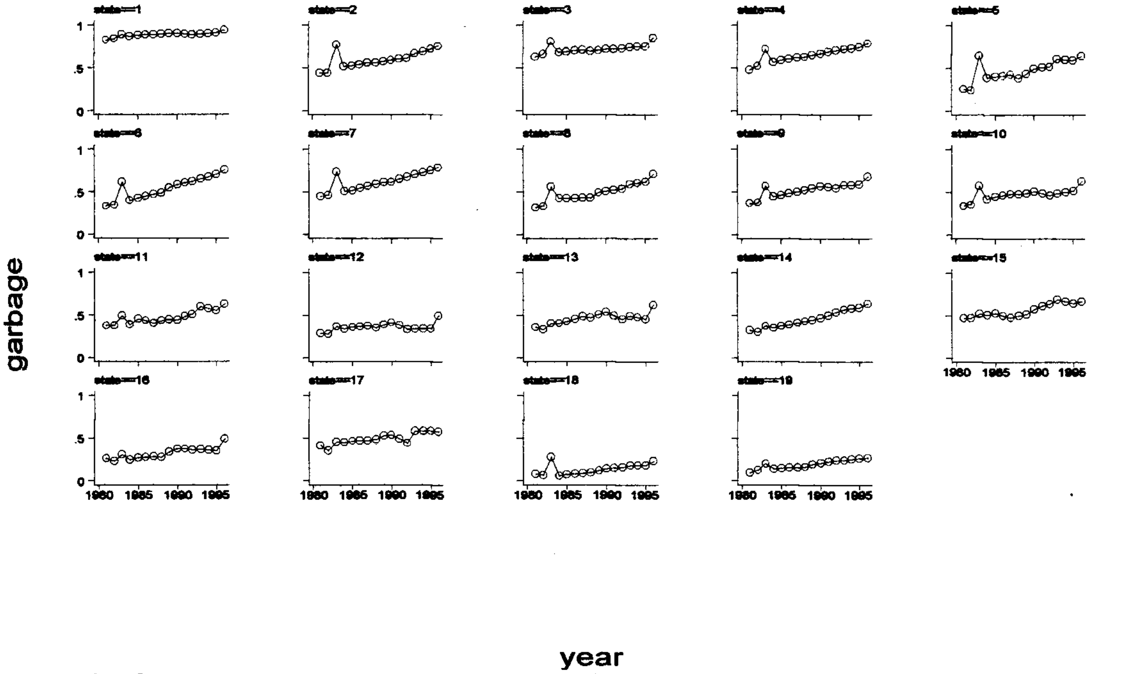
graph 24: hh density across year



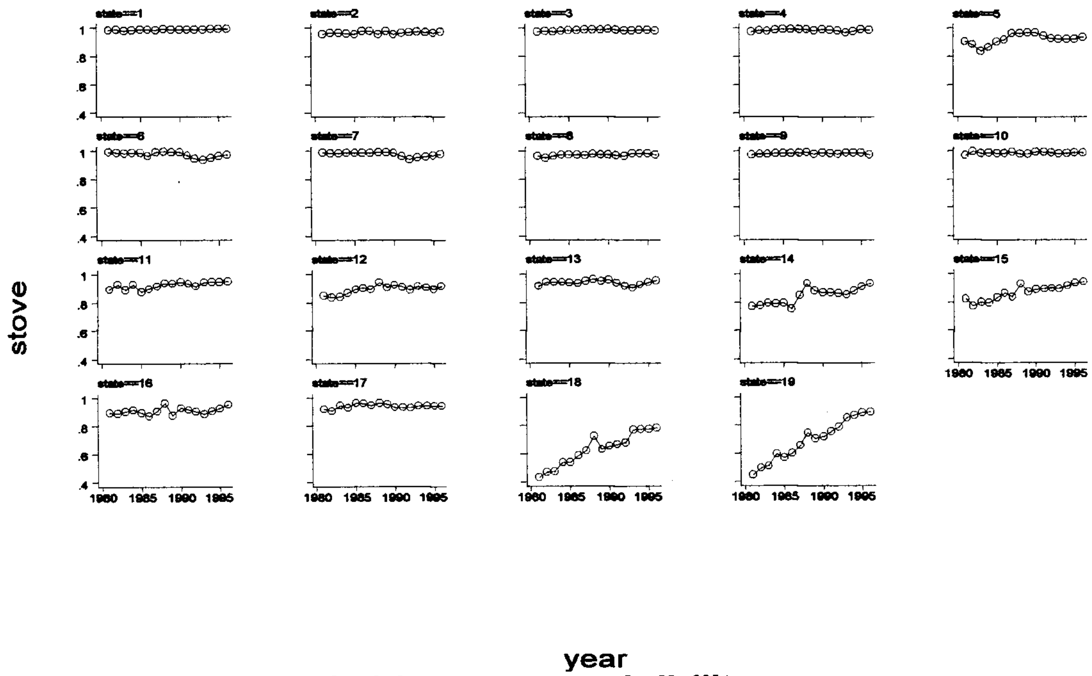
graph 25: access to public sewage services % across year



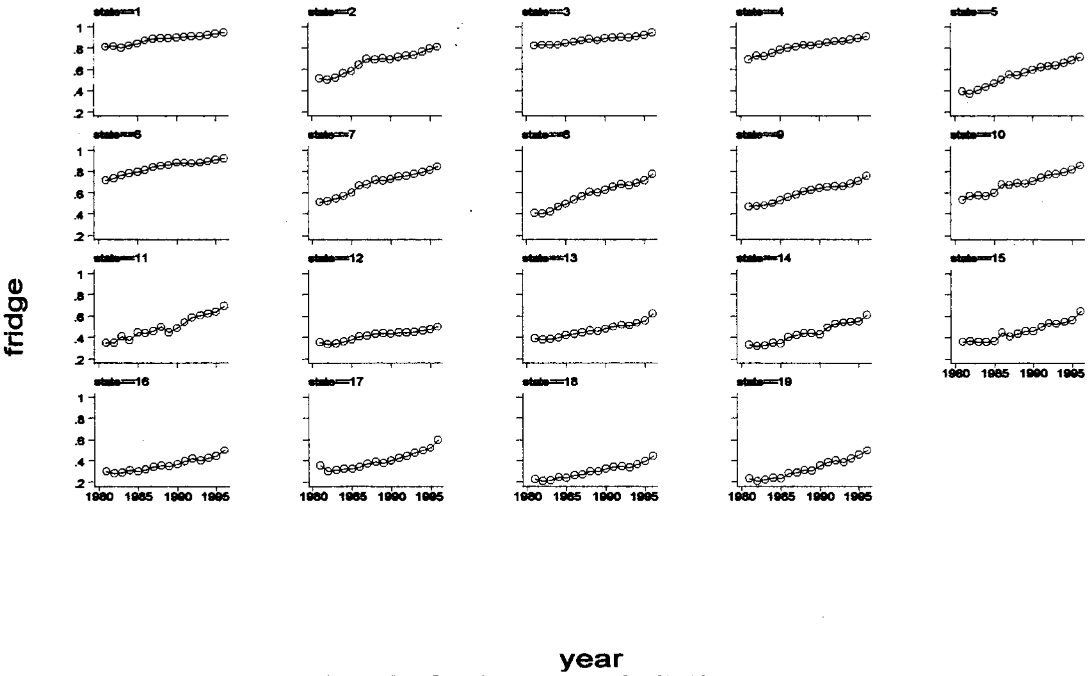
graph 26: access to electric energy % across year



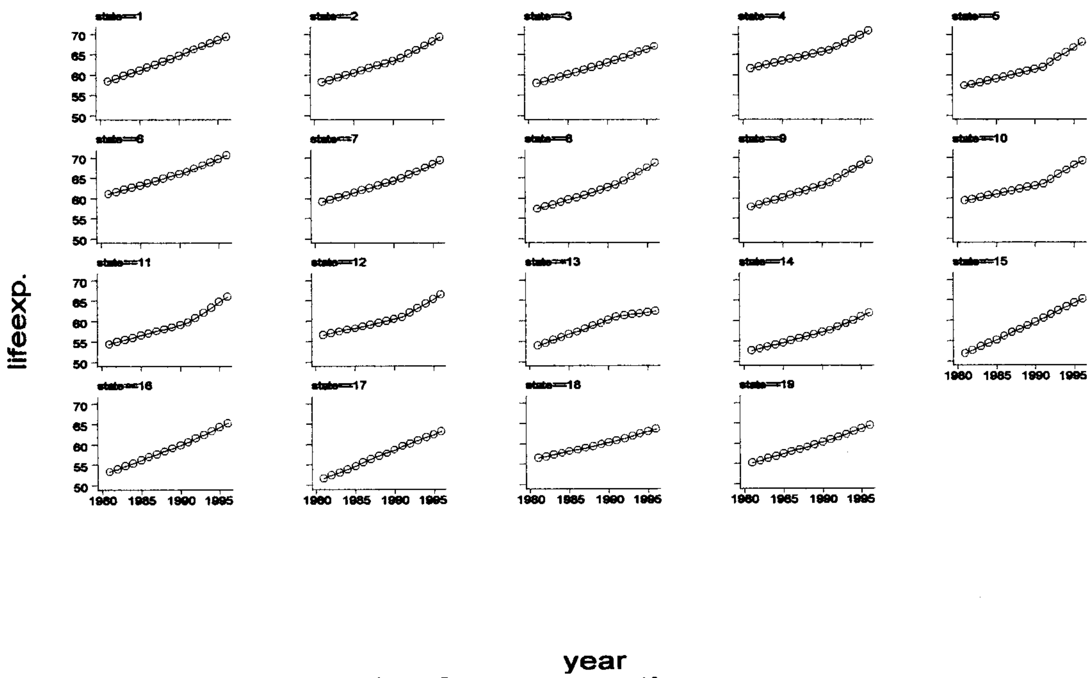
graph 27: access to public garbage services % across year



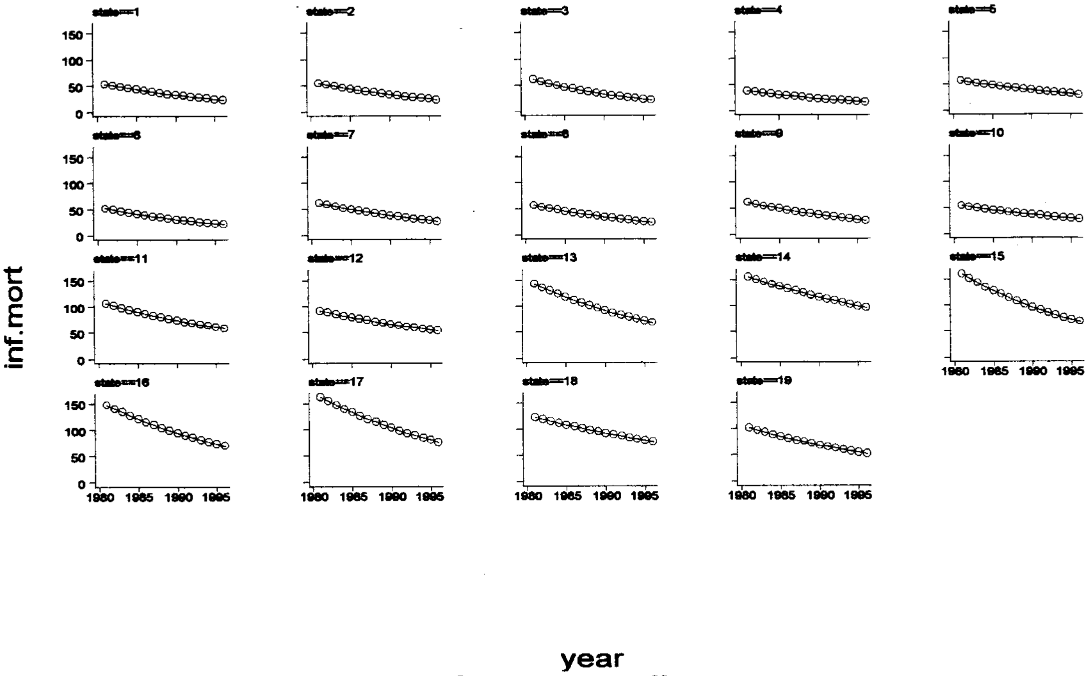
graph 28: hh stove avalaibility across year



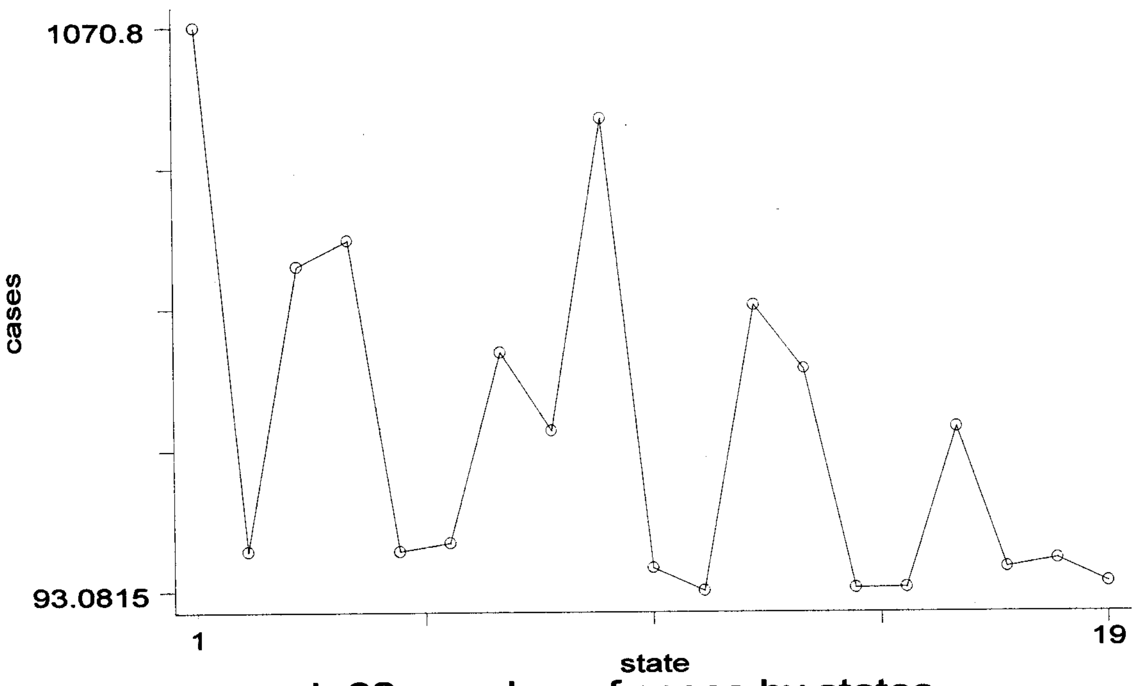
graph 29: hh fridge avalaibility across year



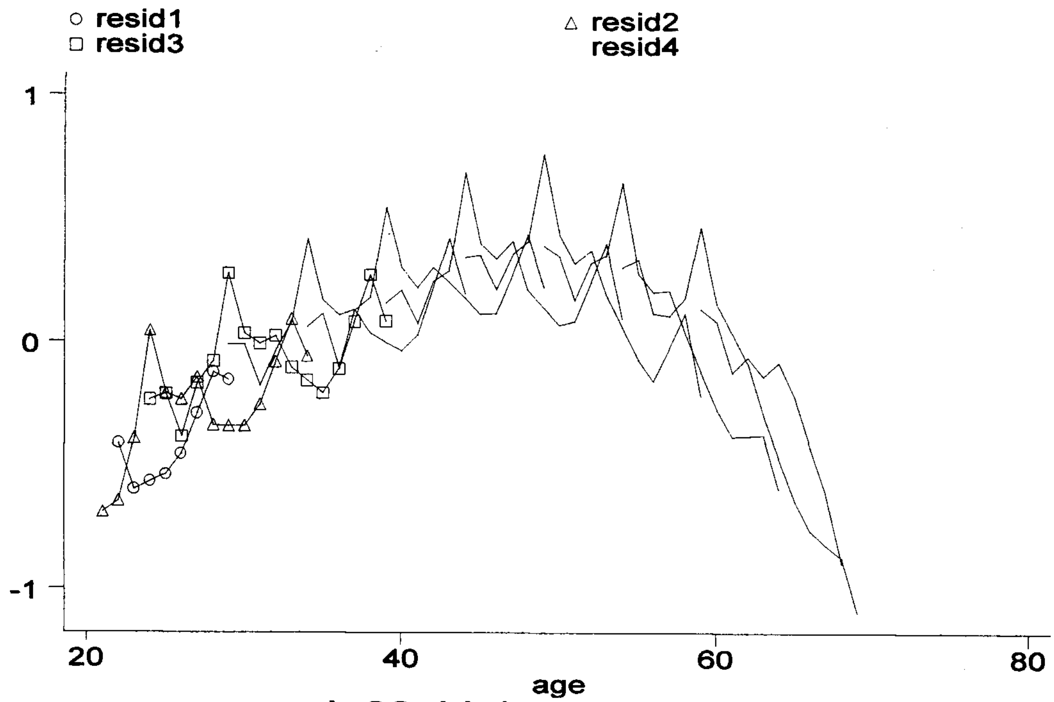
graph 30: life expectation across year



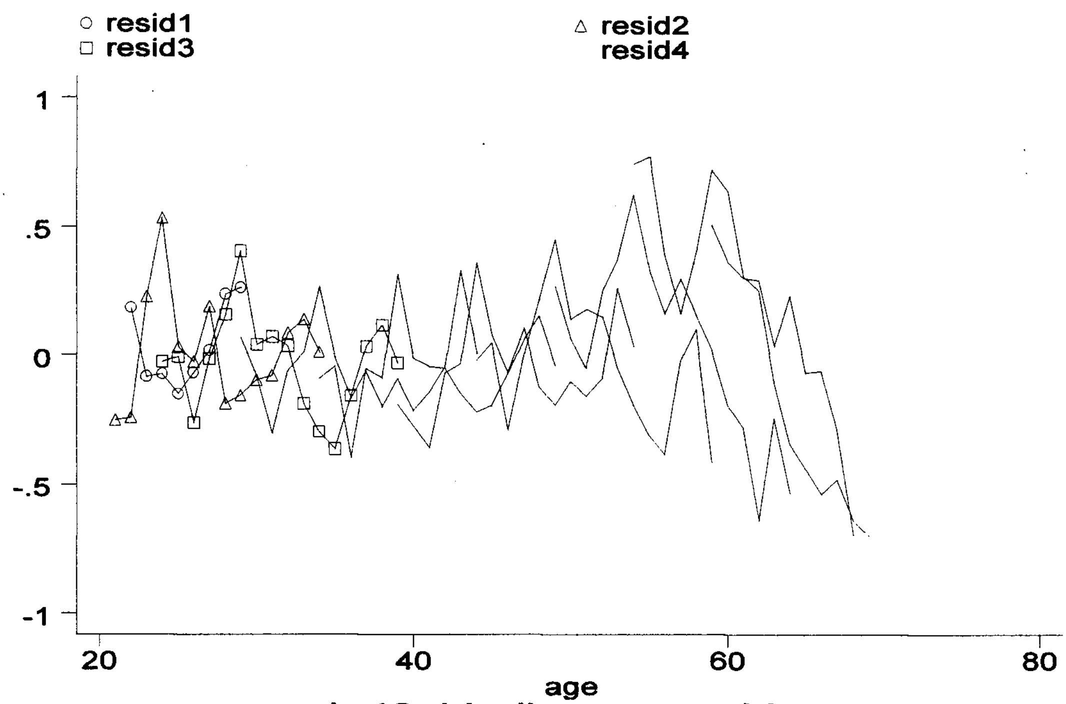
graph 31: infant mortality across year



graph 32: number of cases by states



graph 39: hh income resid



graph 40: hh dincome resid
